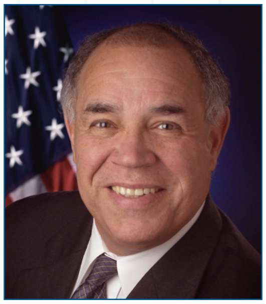
The Implementation
of the
NASA Agency-Wide Application
of the
Columbia Accident Investigation Board Report:

Our Renewed Commitment to Excellence

MARCH 30, 2004

PREFACE



Mr. Fred Gregory
NASA Deputy Administrator

The loss of Shuttle *Columbia* and its crew was a single and tragic accident that has had far-reaching repercussions throughout NASA. The effects were immediately felt in the Shuttle program, but these were followed by the recognition of the relevance to other Human Space Flight programs and ultimately across the broad scope of the Agency's activities. The Columbia Accident Investigation Board (CAIB) in its report issued in August 2003 characterized the accident with two causal statements, one "physical" – the sequence of events on Shuttle Mission STS-107 that destroyed the Orbiter – the other "organizational" – the failures within NASA that allowed those events to occur. We accept the findings of the Board. We will comply with the recommendations. We embrace the CAIB Report. The Board provided NASA with a roadmap "to resume our journey into space." It further provided NASA the framework by which we can renew our commitment to excellence, and – through that – achieve the fundamental scientific breakthroughs that our Nation has come to expect of us.

In the time since the accident, intense analysis and self-reflection have taken place at the individual, team, departmental, and organizational levels throughout NASA. We have instituted a broad array of actions intended to address the breakdowns in structure, process, and technique that contributed to both the physical and organizational failures that led to the loss of *Columbia* and her crew.

NASA has taken specific actions to get the Human Space Flight initiatives back on track. We have made some significant organization changes both in personnel and in structure, and initiated corrective action planning and implementation activities. NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond addresses the engineering and management issues associated with returning the Shuttle to flight status, and NASA's Implementation Plan for International Space Station Continuing Flight applies lessons learned from the loss of *Columbia* to the ISS program. Implementation of these plans is underway.

We are instituting a variety of processes and proactively anticipating future technical problems or issues. With the formation of the NASA Engineering and Safety Center (NESC), we are now able to draw on a diverse mix of outstanding technical talent from across the nation. The NESC is now providing independent testing, analysis, and review of both program and institutional issues across the Agency.

NASA has sought to implement best practices towards improving both safety and mission success. Even prior to the *Columbia* accident, NASA had initiated an effort to collaborate on exchanging ideas with the US Navy on programmatic safety assurance approaches. This effort, known as the NASA/Navy Benchmarking Exchange, was designed to exchange safety knowledge and practices between NASA and the US Navy's SUBSAFE and Naval Reactor Programs. This program was later endorsed by the CAIB Report as having exemplary features from which NASA can learn. We will continue to seek and learn from such efforts.

We are committed to ensuring that all the Agency's endeavors are as safe and successful as possible. An Agency-wide team, under the leadership of Mr. Al Diaz, Director of Goddard Space Flight Center, was commissioned to assess the broader implications of the CAIB Report on activities across the Agency. The final Diaz Team Report, *A Renewed Commitment to Excellence*, released 30 January 2004, concluded that 85 of the 193 recommendations, observations, and findings delineated in the CAIB Report were applicable across the entire spectrum of NASA's activities. It went on to define 40 specific, Agency-wide actions to address those issues, and assigned responsibility for implementation.

Perhaps the most difficult, but necessary, challenge confronting our Agency is the call for us to address the element of culture within NASA. The Agency's "One NASA" initiative had already raised a red flag regarding the Agency's culture in September 2002, and work was underway to address certain elements of our culture, but the call to urgency came with the release of the CAIB Report. That urgency was further reinforced through the feedback NASA received during Safety and Mission Success Week where everyone within the NASA team had the opportunity to discuss the *Columbia* accident and its relevance to their own organizations.

The task of addressing the culture of our Agency has been particularly daunting insofar as portions of the Board's findings were aimed at the very culture that we hold so dear – our "can-do" attitude, and the pride we take in knowing our trade. However, we heard the message and have responded by leveraging existing cultural change activities with expert guidance to focus our efforts and provide us with a point of integration for all Agency initiatives that have cultural implications. We are committed to creating a culture that focuses on safety, that allows everyone to be heard so the best ideas can be considered, and that ultimately enables NASA to achieve excellence.

It is unfortunate that many of the issues facing our Agency today are not new: some first surfaced pursuant to the loss of *Challenger* in 1986, while others arose in the NASA Integrated Action Team (NIAT) Report published on December 21, 2000. In order to propel ourselves to new levels of achievement – indeed, to recover our former level of achievement – NASA's mandate is a commitment to the follow-through necessary to implement the actions resulting from our loss of *Columbia*. The CAIB Report and the resulting Diaz Team Report WILL NOT find their way onto a dusty shelf – instead they will be implemented through a focus on leadership accountability that begins with our Administrator and flows to each individual within the NASA team.

Recall
our purpose

Reflect
upon our vision

Treasure
our mission

Remember
the journey we've traveled

Seek
the truth

Never forget
the sacrifices

- so that we can strive forward.

The memory of the crew of the Space Shuttle *Columbia* will persevere.
Their bravery inspires us all to make a difference.

Acknowledgements

I would like to thank Al Diaz and his Team for "setting the bar" for NASA with their Report, *A Renewed Commitment to Excellence*. Their hard work and dedication to NASA presented us with another opportunity for reflection and introspection following the loss of *Columbia* and her crew. Our One NASA Team, led by Mr. Johnny Stephenson, has worked diligently to produce this document that represents our Agency's next steps for implementing the 40 actions and seven goals from the Diaz Team Report. I commend Johnny and his Team for their dedication, patience, and steadfast drive to provide us those next steps. I want to thank the Assistant Administrators and their staff for their support in developing the implementation approaches and maintaining a willingness to drive change from the top to the grass roots. I also want to thank Valador, Inc. for their help in the preparation of this document and for the insight that they were able to provide from their support of the Diaz Team and the CAIB.

And finally, I wish to acknowledge the many members of our NASA and contractor family that have provided us with valued inputs, feedback, and support following Safety and Mission Success Week and the release of the Diaz Team Report. I encourage you all to continue to send us your thoughts and opinions – NASA people make this Agency great – your voices and opinions are critical to our future successes.

Dedication

I would like to dedicate this Report and our commitment to safety and success to our NASA team, both the civil service and the contractor workforce. In the wake of tragedy you have responded and renewed your commitment to safety and the quest for knowledge. I see your contributions and sacrifices for our Agency and pledge that we will provide you with the tools and resources so that we may once again reach for the stars.

Mr. Fred Gregory
NASA Deputy Administrator

Mr. Theron Bradley
Code D (formerly Code AE)
Office of the Chief Engineer

Ms. Vicki Novak
Code F
Office of Human Resources

Mr. Paul G. Pastorek
Code G
Office of General Counsel

Mr. Thomas S. Luedtke
Code H
Office of Procurement

Mr. Jeffrey E. Sutton
Code O (Formerly Code J)
Office of Institutional and Corporate Management

Mr. Bryan D. O'Connor
Code Q
Office of Safety and Mission Assurance

Mr. David A. Saleeba
Code X
Office of Security Management and Safeguards

CONTENTS

List of Exhibits

1.0 Executive Summary

Diaz Team Report, Chapter 10 Summary and Next Steps, Page 50:

For NASA to embark on the new pathway, some fundamental reforms must be instituted. These are encompassed by the 40 Diaz Team actions and seven goals identified in the Report.

This report, *The Implementation of the NASA Agency-wide Application of the Columbia Accident Investigation Board Report: Our Renewed Commitment to Excellence*, presents a plan for the implementation of the 40 Diaz Team actions and seven goals identified within its January 2004 report, *A Renewed Commitment to Excellence*. The Diaz Team identified 85 broadly applicable Recommendations, Observations, and Findings (R-O-Fs) from the Columbia Accident Investigation Board's report that translated into 40 Agency-wide action items. The Team's report went on to assign responsibility for each of the 40 actions but deferred the completion of detailed action plans and schedules to the responsible organizations within NASA, thereby encouraging a sense of ownership and commitment while also recognizing the need for more methodical planning such that the objectives of each action are realized. This report is the first step in that methodical planning process as we elaborate on the detailed accountabilities resulting from each action and detail the approach to accomplishing each of the actions.

Mr. Sean O'Keefe, NASA's Administrator, embraced the findings of the Diaz Team as one of the necessary elements toward renewing the Agency's focus on excellence and thus raising the bar of performance for NASA. The Agency also recognized the need for leadership accountability to achieve such a goal. To that end, the Deputy Administrator (DA) oversees all activity in response to the *Columbia* Accident and thus oversees the implementation

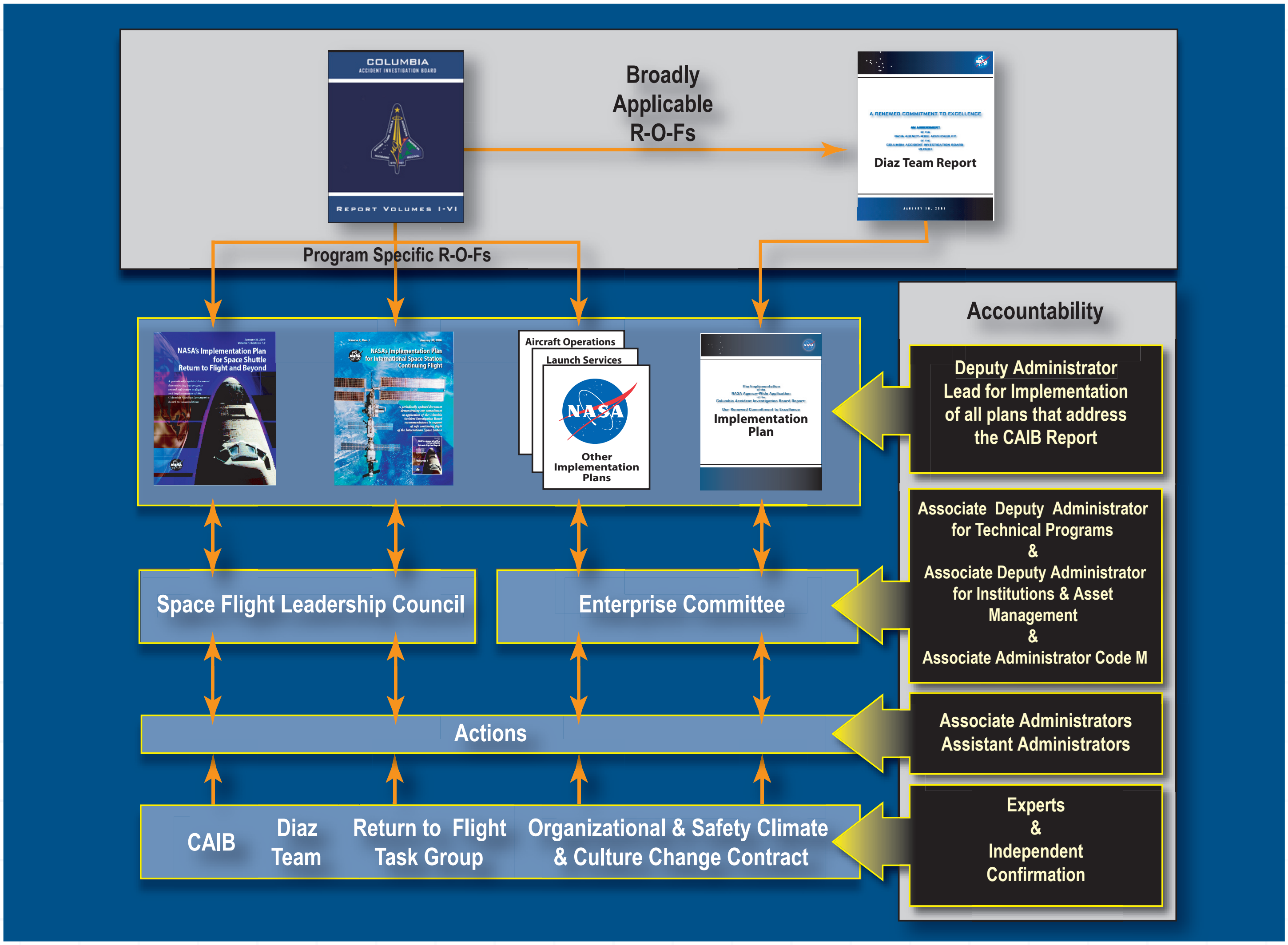


Exhibit 1.0-1. Program specific and Agency-wide CAIB-related actions, will be tracked with accountability through the Deputy Administrator.

of actions resulting from the Diaz Team Report. The DA has empowered the Associate Deputy Administrator for Technical Programs (ADA/T) and the Associate Deputy Administrator for Institutions and Asset Management (ADA/I) to lead the implementation of those actions identified within the Diaz Team Report. The ADA/T is specifically responsible for the implementation of the 40 Diaz Team actions while the ADA/I is specifically responsible for the implementation of cultural activities within the Agency. They will utilize the Enterprise Committee (EC) to approve and solicit necessary resources for the implementation of all actions. The EC will also be the forum to report progress and identify issues to the DA. The ownership and day-to-day management of the Action Plans is the responsibility of Assistant Administrators (AA), hereafter called Action Owners, of the following organizations:

- Code D (Office of the Chief Engineer)
- Code F (Office of Human Resources)
- Code G (Office of the General Counsel)
- Code H (Office of Procurement)
- Code O (Office of Institutional and Corporate Management)
- Code Q (Office of Safety and Mission Assurance)
- Code X (Office of Security Management and Safeguards)

Section 4.0 of this report presents the approaches for implementing the 40 Diaz Team actions. After the release of this report the Action Owners will complete their detailed action plans to include milestones, resource requirements, and schedules for each of its assigned actions. Each plan will be subject to review by the Enterprise Committee and approval by the appropriate ADA (ADA/T or ADA/I). The ADA, through the EC, will conduct periodic progress reviews. The overall structure is shown in Exhibit 1.0-1.

Tracking and management of the Action Plans will be done with the Corrective Action Tracking System (CATS) II that is also being used to track and manage all *Columbia*-related actions. The Diaz Team will periodically reconvene to provide independent assessment of the progress of the Action Plans in accordance with the original intent specified by that team. Its initial review of plans and progress is expected in July 2004.

The Diaz Team actions are structured into seven categories that include: leadership; learning; communication; processes and rules; technical capabilities; organizational structure; and risk management. The seven Diaz Team categories have seven associated and specific goals. These seven goals, unlike the 40 actions, were not assigned to any specific organization for "ownership." The seven specific goals are expected to be addressed by implementation of the 40 actions; however, the ADA/T and the Diaz Team will reassess the degree to which this assertion is occurring as progress is being made toward accomplishment of the actions within a given category.

The Diaz Team Report did not specifically address culture change within NASA, but it did recognize the need for cultural change and the implementation of its 40 actions will represent one step toward elevating the culture of the Agency. This report is intended to address the Diaz Team 40 actions and seven goals. A cultural change plan that presents an overview and detailed implementation of culture change activities will follow in a later document. Other efforts are underway as well. This report presents an overview of current culture change activities across the Agency and presents the Agency's approach to integrating these activities in a manner that ensures the achievement of such change.

In essence, this report represents a commitment by the leadership of NASA – a commitment to learning, a commitment to the application of that learning, and a commitment to excellence.

Dr. Michael Greenfield
Associate Deputy Administrator for Technical Programs

Mr. Jim Jennings
Associate Deputy Administrator for Institutions and Asset Management

2.0 Background and Purpose of the Diaz Team Report Implementation Plan

Diaz Team Report, Preface, Page 1:

If NASA is to avoid another day like February 1, 2003, we must meet our mission objectives safely and renew our commitment to excellence. In order to do this, we must identify corrective actions for each of the causes of the accident, and then implement them fully and effectively. The CAIB Report should serve as a catalyst for change in the way all of us perform our work. It should prompt a renewed understanding of our shared purpose.

2.1 Background

Following the release of the Columbia Accident Investigation Report, Mr. Sean O'Keefe, NASA's Administrator, asked Mr. Al Diaz, Director of Goddard Space Flight Center, to convene a team to look at the broader applicability, across NASA as an Agency, of the 193 R-O-Fs identified within that report. This team consisted of three Center Directors and two headquarters executives including:

- Mr. Scott Hubbard from Ames Research Center
- Dr. Julian Earls from Glenn Research Center
- Mr. Jim Kennedy from Kennedy Space Flight Center
- Ms. Vicki Novak, the Assistant Administrator for Human Resources, Code F
- Dr. Ghassem Asrar, Associate Administrator for Earth Science, Code U

The Diaz Team released its findings on January 30, 2004 in its report, *A Renewed Commitment to Excellence, An Assessment of the NASA Agency-wide Applicability of the Columbia Accident Investigation Board Report*.

The Diaz Team Report identified 85 applicable R-O-Fs that resulted in 40 actions and seven goals for the Agency's adoption. The Diaz Team further identified the Agency-wide applicability of the actions along with recommendations for ownership of each action. Details of these 40 specific actions and their traceability back to the CAIB Report can be found in Appendix A. The Diaz Team Report included a summary, which focused on three overarching reforms that must succeed. These are:

- NASA must assure that appropriate checks and balances are in place to develop and operate its missions safely, and must undertake the organizational changes necessary to make this happen.
- NASA must enhance communications at all levels with a focus on fostering diversity of viewpoints and eliminating fear of retribution.
- NASA must focus on the ways it is managing risk.

These reforms will be achieved if the 40 actions are implemented as intended.

The Diaz Team Report was not intended to provide detailed action plans and schedules to the recommended Action Owners. The Diaz Team felt that to do so would remove a sense of ownership for the actions. Rather than being prescriptive, the Diaz Team identified opportunities for the Action Owners to consider the issues, devise appropriate plans of action, and take complete ownership over the change opportunities.

With the release of the Diaz Team Report, the Deputy Administrator assigned the One NASA Team the role of facilitating the development of an implementation approach for the 40 specific actions and seven goals by working with the Agency leadership and each of the Action Owners. This Implementation Plan is a final product resulting from that assignment.

2.2 Purpose

The purpose of this document is singular – to focus on the plan and approach for implementing actions of an Agency-wide nature that were identified by the Diaz Team. As such, the Diaz Team Report is our guide; the 40 Diaz Team actions and seven goals serve as our starting point. This plan will:

- Present the approach for implementing each of the 40 Diaz Team actions,
- Address the approach for meeting the seven goals identified within that report; and
- Outline the approach for addressing the organizational culture of the Agency.

This document will not provide the final detailed Action Plans in response to the Diaz Team Report. The detailed and "living" Action Plans for each of the Diaz Team actions and the detailed plan for organizational culture change will subsequently be developed and released as described in this report.

3.0 Structure for Implementation Management

Diaz Team Report, Chapter 8 Organizational Structure, Page 44:

The structure of an organization should help clarify roles and responsibilities of individual employees, work groups, and leadership……for NASA to succeed with any new organization, every member of the workforce should be able to answer three basic questions:

- *Do you know where you fit into the organizational structure?*
- *Do you know to whom you report, and who reports to you?*
- *Do you know your responsibility, authority, and accountability?*

The Diaz Team Report assigned the responsibility for each of the 40 specific actions to a single Headquarters organization or Action Owner; however, it did not identify an overall management framework for leadership accountability and measurement of program milestones and implementation success. The Deputy Administrator has this responsibility to oversee all activities in response to the *Columbia* accident and the implementation of the Diaz Team actions. The One NASA Team, under the purview of the Deputy Administrator's organization, was assigned the responsibility to develop an integrated implementation approach and coordinate the Implementation Planning with the assigned Action Owners following the release of the Diaz Team Report in January 2004. Each Action Owner was responsible for developing the approach to implementation included in Section 4.0.

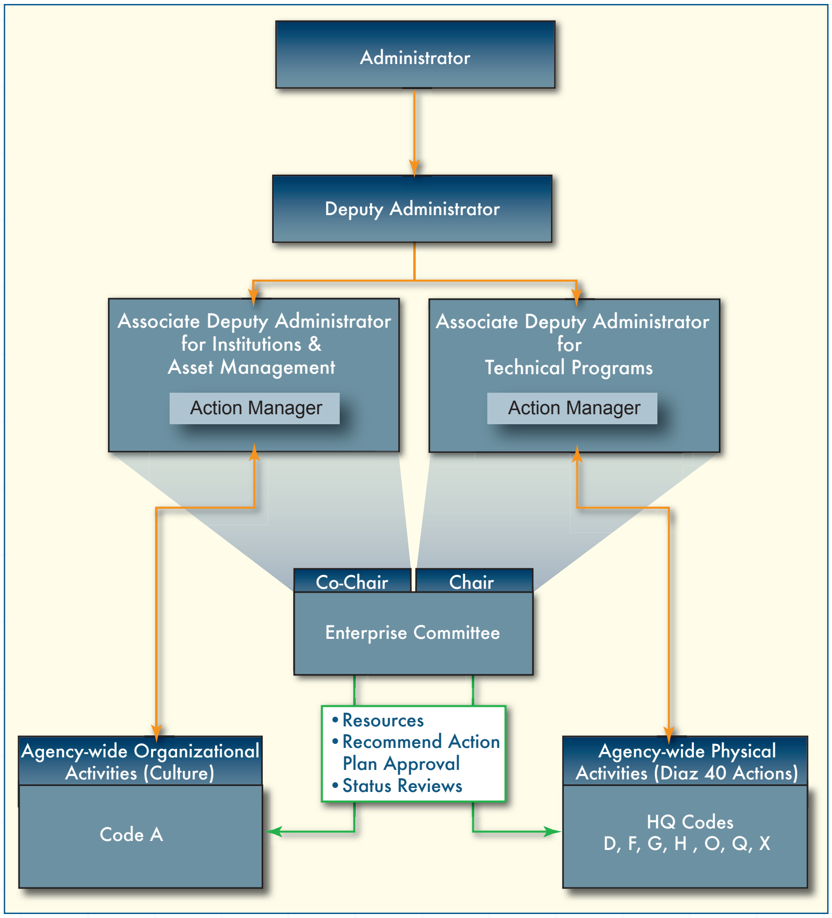


Exhibit 3-1.1. Each of the 40 actions specified in the Diaz Team Report has Leadership assigned, and is accountable to ensure completion.

3.1 Organization for Implementation Management

The Diaz Team Report, *A Renewed Commitment to Excellence* focused on broad, Agency-wide applicability of the CAIB Report. The organization and each individual that will manage the implementation of the 40 actions and seven goals must be given the authority, and resources (funding, people), and also be held accountable for seeing it through. Exhibit 3-1.1 highlights that accountability chain and the overall reporting structure to the NASA Deputy Administrator. In this accountability chain, the DA is ultimately responsible for overseeing actions resulting from the Diaz Team Report. The ADA/T is responsible for implementation of the 40 Diaz Team actions while the ADA/I is specifically responsible for the implementation of cultural activities within the Agency. An Action Manager will be assigned to work under the guidance of each Associate Deputy Administrator. They will be responsible for coordinating and integrating all activities under the purview of their respective ADA. They will also be responsible for monitoring action progress and scheduling progress reviews. The ADA/T and ADA/I will utilize the EC to approve and solicit necessary resources for the implementation of the actions. The EC will also be the forum to report progress and identify issues to the DA. The Action Owners are responsible for the day-to-day management and implementation of the Action Plans. Those individuals are identified as the Assistant Administrators (AA) of the following organizations:

- Code D (Office of the Chief Engineer)
- Code F (Office of Human Resources)
- Code G (Office of the General Counsel)
- Code H (Office of Procurement)
- Code O (Office of Institutional and Corporate Management)
- Code Q (Office of Safety and Mission Assurance)
- Code X (Office of Security Management and Safeguards)

The Action Manager will continuously work with each Action Owner to facilitate implementation. Exhibit 3.1-2 summarizes the responsibility, authority, and accountability of each person associated with implementation of the actions. The Diaz Team will periodically meet to review the implementation process and ensure that the intended objectives are being met.

The DA is responsible for ensuring that NASA has implemented the CAIB R-O-Fs, and ensuring the safety of NASA missions and the overall direction for the development of actions and associated plans that resulted from the *Columbia* accident.

The EC is an existing senior executive body that represents an Agency-wide cross-section of leaders, and reports to the DA. The EC is chaired by the ADA/T and is co-chaired by the ADA/I. The EC will assist both the ADA/T and ADA/I by recommending the approval of the detailed plans including budgetary and resource requirements, and performing periodic progress reviews.

The Action Manager will develop a review schedule for the 40 actions and seven goals. Each of the 40 actions and seven goals will be reviewed in accordance with the Action Manager's schedule. They will be reviewed for progress towards implementation and any issues that have developed since the last review.

Position	Responsibility	Authority	Accountability
Deputy Administrator (DA)	Ensure that the Agency follows through on the recommended actions and goals of the Diaz Team Report	The ability to assign actions and completion metrics to Action Owners, to apply and redirect the use of resources	To the Administrator for the successful implementation of all 40 actions, seven goals, and NASA's plan for cultural change
Enterprise Committee (EC)	Ensure that the implementing organizations are following through with the approved actions	Review authority for action approaches and input to ADA/T or ADA/I and the authority to recommend budget allocations	To the Deputy Administrator to ensure that the implementation is on schedule and consistent with the intent
Associate Deputy Administrator for Technical Programs (ADA/T)	Leadership responsibility for implementation of the 40 Diaz Team actions and seven goals	Approval of 40 Diaz Team Action Plans resulting from the Diaz Team Report that are primarily technical, i.e. related to the physical causes of the *Columbia* accident. Authority to recommend budget allocations and adjustments	To the Deputy Administrator to ensure that the implementation is on schedule and consistent with the intent
Associate Deputy Administrator for Institutions and Asset Management (ADA/I)	Leadership responsibility for implementation of Agency-wide cultural actions	Approval of Agency-wide Action Plans that are primarily cultural i.e. related to the organizational causes of the *Columbia* accident. Authority to recommend budget allocations and adjustments	To the Deputy Administrator to ensure that the implementation is on schedule and consistent with the intent
Assistant Administrators/ Action Owners	Implementation of the assigned actions	Delegation of detailed implementation to specific teams and the primary interface with other collaborative NASA organizations	To the ADA/T and EC for the timely development and successful execution of the action plans which meet the Diaz Team requirements
Action Manager	Provide day-to-day oversight and coordination of all actions	Identify, resolve or escalate issues to the appropriate Associate Deputy Administrator for cognizance and resolution	To the ADA/T and/or ADA/I to ensure that the implementation is on schedule and consistent with the intent
Diaz Team	Provide independent assessment of the implementation progress and adherence to the intent of the Diaz Team Report	Recommendation authority to the EC for any potential corrective actions	To the EC for meeting independent review plans

Exhibit 3.1-2. Responsibility, Authority, and Accountability are important elements and must be understood by everyone affected by this plan.

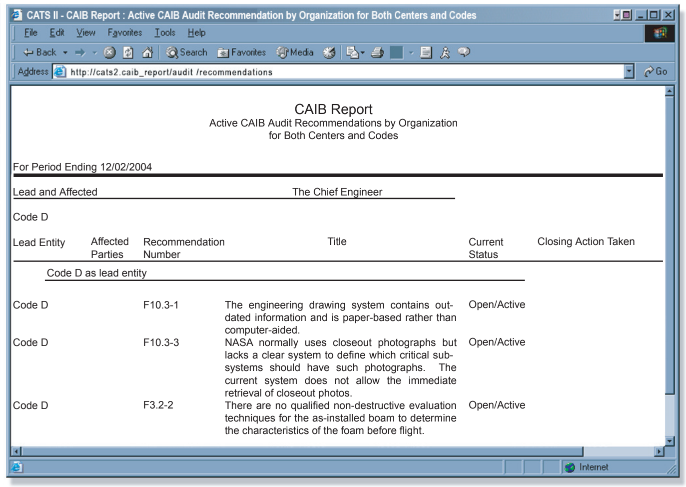
The Action Owners may assign implementation responsibility for their assigned actions to someone within their organizations; however, this does not transfer the accountability from the Action Owner for plan completion. Each Action Owner is responsible for determining the most appropriate means internally for the successful completion of the assigned actions.

3.2 Action Progress Tracking

The progress of all Diaz Team actions will be tracked using the Corrective Action Tracking System (CATS) II. CATS II is currently being used to track other CAIB actions and it provides the AAs, EC, and the DA with a straightforward means for assessing progress towards completion. CATS II will track not only the status of each action implementation, but all associated subtasks and milestones. This system will provide executive level status and reports, as shown in Exhibit 3.2-1. CATS II will also provide the status of metrics to measure the progress of each action.

CATS II was developed to track the schedule and cost of recommendations for corrective actions from a variety of audit sources that include the NASA Office of Inspector General (OIG), General Accounting Office (GAO), Defense Contract Audit Agency (DCAA), and International Standards Organization (ISO) 9000.

Exhibit 3.2-1 shows the single executive view for all 40 actions. The DA through his own "dashboard" can review the overall status of the action plans that details program completion subject to each defined implementation metric set. CATS II allows all participants requiring access to manage actions for which they are responsible. Each Action Plan is maintained in a web-enabled database which is linked to the executive dashboard.


CATS II - CAIB Report : Active CAIB Audit Recommendation by Organization for Both Centers and Codes

File Edit View Favorites Tools Help

Address http://cats2.caib_report/audit /recommendations

CAIB Report
Active CAIB Audit Recommendations by Organization
for Both Centers and Codes

For Period Ending 12/02/2004

Lead and Affected — The Chief Engineer

Code D

Lead Entity	Affected Parties	Recommendation Number	Title	Current Status	Closing Action Taken
Code D as lead entity					
Code D		F10.3-1	The engineering drawing system contains outdated information and is paper-based rather than computer-aided.	Open/Active	
Code D		F10.3-3	NASA normally uses closeout photographs but lacks a clear system to define which critical subsystems should have such photographs. The current system does not allow the immediate retrieval of closeout photos.	Open/Active	
Code D		F3.2-2	There are no qualified non-destructive evaluation techniques for the as-installed boam to determine the characteristics of the foam before flight.	Open/Active	

Exhibit 3.2-1. CATS II will be used to track the Implementation of the 40 Diaz Team actions.

3.3 Schedule (FY04)

The implementation schedule is highly dependent on the resulting detailed action plans that will be due shortly after completion of this plan. The current schedule calls for the completion and acceptance of all detailed action plans in May, as shown in Exhibit 3.3-1. The Deputy Administrator will review the status of the implementations at least once every two months. The Diaz Team is already scheduled to reconvene for a review in July; subsequent reviews will be scheduled by the EC.

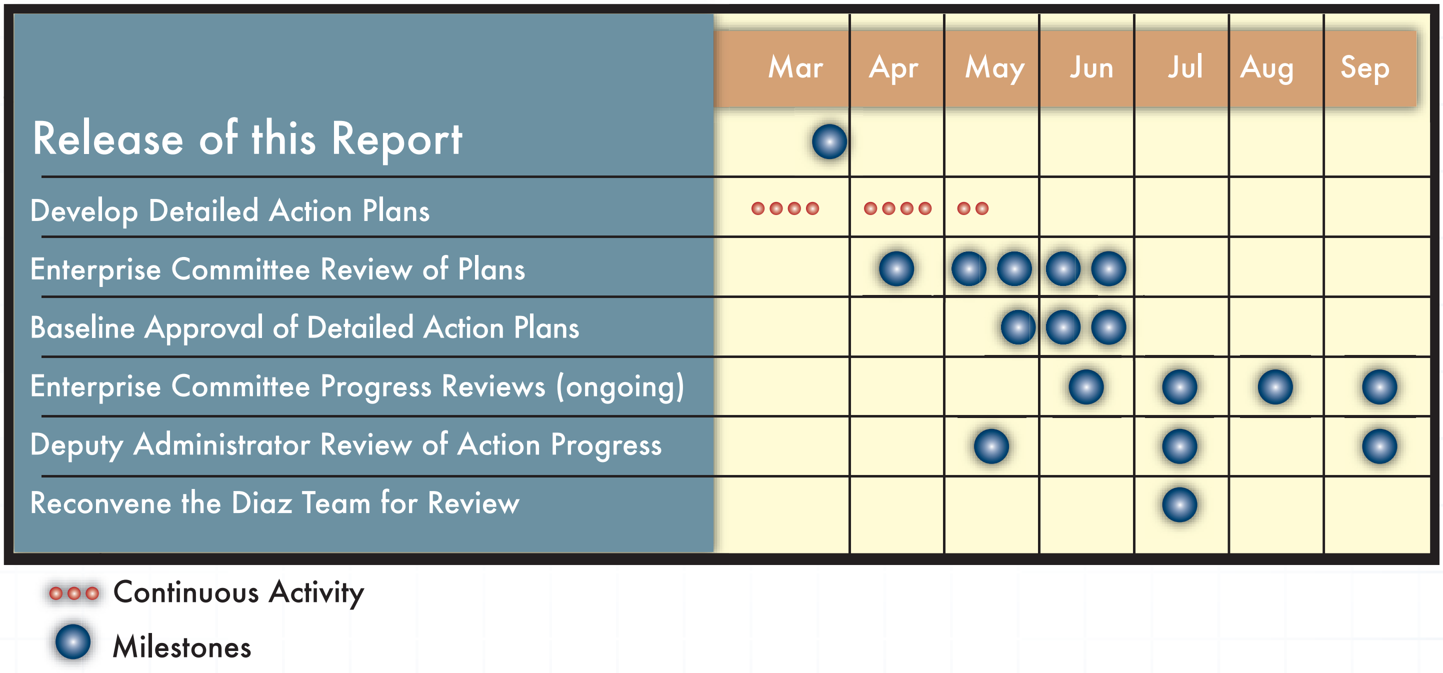


Exhibit 3.3-1. Detailed Action Plans are due 45 days after the release of this Plan.

4.0 Specific Approaches to Implementing the 40 Diaz Team actions

Diaz Team Report, Chapter 10 Summary and Next Steps, Page 50:

The responsibility for preparing implementation plans to accomplish the 40 “specific actions” in the Diaz Team Matrix was given to the appropriate NASA Headquarters organizations. The responsibility for accomplishing the seven “Diaz Team Goals” is not identified in the Report. However, it is anticipated that the NASA Deputy Administrator will provide direction to the development of all implementation plans.

The CAIB Report investigated the Shuttle program to determine the physical and organizational causes of the loss of *Columbia* and its crew. The report identified broad cultural and organizational flaws that appeared pervasive through the Agency. The Diaz Team provided an assessment of the broad, Agency-wide applicability of the report. This section details the findings of the Diaz Team and the subsequent approaches that are being planned by the responsible Headquarters organizations for their successful implementation.

4.1 Background and Overview of the Diaz Team Findings

The Diaz Team began by selecting 85 broadly applicable R-O-F’s out of the 193 discussed in the CAIB Report. The Diaz Team initially organized these 85 R-O-Fs and associated actions into a matrix called the Columbia Agency-wide Action Matrix (CAWAM) which identified traceability to the CAIB Report as well as an initial assignment of each action to a Headquarters organization for implementation responsibility. The CAWAM was provided to the NASA community for review and comment during Safety and Mission Success Week. It is included in Appendix A of this document for reference. Subsequently, the actions were divided into seven distinct categories as shown in Exhibit 4.1-1.

The actions, numbered 1 through 40, were each assigned to a specific category. This assignment is summarized in Exhibit 4.1-2; full action details and traceability back to the CAIB Report are provided in Appendix A.

The responsibility for implementing the 40 actions was then finalized and apportioned across the appropriate previously identified organizations at NASA Headquarters.

Leadership	Leadership is the action of inspiring, guiding, directing, or influencing people. Leadership is not a position in the hierarchy of management, but rather a series of behaviors and actions, which enable others to achieve goals and shared vision. Leadership occurs throughout all levels of an organization.
Learning	Learning is the acquisition of knowledge or skill. It can be gained through formal education and training, experiences and expertise gained on-the-job, and through life-long experience. Learning outcomes can include the acquisition of knowledge and/or understanding, as well as changes in behavior.
Communication	Communication is the exchange of information between individuals, or groups by means of speaking, writing, or a common system of signs or behavior. One goal of communication is a sense of mutual understanding; both parties must speak the same language.
Processes and Rules	A process is a series of actions directed toward a particular aim, dealing with people or things. A process can also be the means to deal with somebody or something according to established procedures. Rules may be authoritative principles that govern individual or group behavior. Rules can also be used to ensure accountability, to establish authority within an organization, and to convey knowledge.
Technical Capability	Technical capability is the set of abilities needed to accomplish specialized tasks, in fields such as industrial applications and applied science. It refers to skilled staff members and the methods, tools, and resources they use to perform their work effectively. Technical capability is also the ability to employ a technique according to a strict interpretation of the rules.
Organizational Structure	An organization is a group of people identified by shared purpose. It defines the relationships among separate staff elements that are arranged in a coherent structure. An organizational structure, then, is the framework that enables a system made up of separate but interrelated parts to function as an orderly whole. For example, organizational structure describes the ways in which the constituent components of NASA are able to work together.
Risk Management	Risk is the potential for injury, damage, or loss to individuals or property. Risk is also the statistical chance that such a hazard will occur, especially from the failure of an engineered system. Risk management is the systematic process of analyzing, quantifying, and managing risk as one would another resource available in the execution of a project.

Exhibit 4.1-1. The Seven Diaz Team Categories and Their Definitions.

The One NASA team was assigned the responsibility of coordinating the development of implementation approaches and defining the process by which the detailed action plans will be managed.

Bin	Diaz Team Action	Description	HQ Lead	CAIB R-O-Fs
Leadership	14	Identify policies associated with workforce and infrastructure/facilities management and obsolescence.	O	O10.6-2
Leadership	15	Form a workgroup to benchmark best practices from Federal agencies (e.g., DoD, FAA, DOE), and commercial industries.	D	O10.6-3
Leadership	17	Review current training strategy/policies on management, leadership, and exchange programs used by government and commercial industry (including NASA contractors) for best practices.	F	O10.12-1
Leadership	28	Develop a clear process for management chain of command and communications within a program and among government organizations and program management/contractor interfaces for anomaly request and resolution.	D	F6.1-4, F6.2-6, F6.3-2, F6.3-6, F6.3-8, F6.3-9, F6.3-12, F6.3-15, F6.3-18, F6.3-19, F6.3-22
Leadership	30	Expand upon the process for independent program reviews (Independent Assessments, Independent Implementation Reviews, and Non-Advocate Reviews) that require re-review when any interim major milestone slips to determine the impact on mission completion schedule and cost risk.	D	F6.2-1
Leadership	32	Develop a clear process for management chain of command for program management.	D	F6.2-3
Leadership	33	Perform an assessment of best industry practices for R&D, completion, and operational programs to assess the management of schedule and cost risk through the development of management reserves.	D	F6.2-5
Learning	7	Review current policies associated with developing emergency procedures and operational contingencies and associated training and certification.	D	R6.3-1, F6.3-23
Learning	38	Review current policies and standards for decision support tools.	D	F7.4-9
Learning	39	Review current policies and standards for databases and knowledge sharing.	D	F7.4-10, F7.4-11
Communication	24	Identify clear chains of command in a program including responsibility, accountability, and authority for issue communications.	D	F4.2-4
Communication	35	Review communications policies and reports. The review will focus on the requirements for formal reporting during normal and emergency/crisis times. For formal reporting during normal operating tempo, the frequency of the reports shall be determined, and who produces/reviews, and approves these reports.	D	F6.3-24, F6.3-26, F6.3-27, F6.3-29

Exhibit 4.1-2. The Diaz Team 40 actions Grouped into Seven Categories.

Bin	Diaz Team Action	Description	HQ Lead	CAIB R-O-Fs
Processes and Rules	1	Review/develop current policy or guidance that assures critical event data is collected, observed, and analyzed.	D	R3.4-1, F3.2-8
	2	Develop a standard for comprehensive program risk management and observable data collection for all phases of program development, test, operation, and enhancement to be used for program management, improvement, anomaly/disaster reconstruction.	D	R3.4-2
	12	Review current initiatives for International Standards Organization (ISO) and Software Engineering Institute Capabilities Maturity Model (SEI CMM) across the agency to determine if they are meeting the objectives of NASA and are cost and operationally effective.	D	O10.4-4
	13	Review current policies program and technical audits across NASA. Determine if the policies, if implemented, meet the intent of the CAIB recommendation.	D	O10.5-1, O10.5-3
	19	Review procedures for anomaly identification and characterization.	Q	F3.2-5, F3.2-7, F3.2-8
	26	Review a minimum of three programs to determine if they are “Following the Rules.”	D	F6.1-1, F6.3-16
	34	Determine if NASA needs a central source for maintaining security clearances.	X	F6.3-20
Technical Capabilities	4	Develop a standard for the development, documentation, and operation of models and simulations.	D	R3.8-2, F3.8-6, F6.3-10, F6.3-11
	10	Review current policies and capabilities associated with configuration control, closeout photographs, and engineering drawings. Determine if the policies, if implemented, meet the intent of the CAIB recommendation.	D	R10.3-1, R10.3-2, F10.3-1, F10.3-3
	18	Review current policy, criteria, and contractual guidance regarding government acceptance.	H	F3.2-2, F3.3-2
	21	Identify methods used by other test organizations to perform remote system testing and anomaly resolution.	D	F3.4-3, F3.4-4, F3.4-5
	23	Develop a standard for the modeling and testing (both destructive and nondestructive) of system components and assemblies.	D	F4.2-1, F4.2-2
	25	Identify programs of similar nature with applicable practices for such activities as closeout photographs, program documentation and configuration management to NASA operational and R&D initiatives.	D	F4.2-14

Exhibit 4.1-2 (Continued). The Diaz Team 40 actions Grouped into Seven Categories.

Bin	Diaz Team Action	Description	HQ Lead	CAIB R-O-Fs
Organization Structure	9	Develop plans for implementing an Independent Technical Engineering Authority (ITEA) of the scope envisioned by the CAIB.	Q	R7.5-1, R7.5-2, R9.1-1, F7.1-1, F7.4-2, F7.4-4, F7.4-12, F7.4-13
	27	Develop a standard and process for independent review of all program requirements and operational constraints for consistency and identify all program waivers.	D	F6.1-2, F6.1-6
	31	Perform a comprehensive assessment of major program interdependencies.	D	F6.2-2
	37	Review current policies and standards from an organizational structure and responsibility perspective.	D	F7.4-6, F7.4-8
Risk Management	3	Review current policy, criteria, and contractual guidance regarding supply chain, sparing, and obsolescence policy.	D	R3.8-1
	5	Review current policies associated with the uniform application of risk acceptance for orbital operations.	Q	R4.2-4, F4.2-16
	6	Develop a standard for program development strategy based on the program focus of R&D versus operational system or infrastructure that focuses on the comprehensive assessment of program management, technical, and operational risks; all of these factors must be incorporated into the development of an integrated program schedule.	D	R6.2-1
	8	Review the current Memorandum of Agreement (MOA) with the National Imagery and Mapping Agency, which is now called the National Geospatial-Intelligence Agency (NGA).	G	R6.3-2
	11	Review current policies associated with public risk on launch, overflight, end of life reentry of previously manned or robotic spacecraft, and recovery of any NASA asset as well as the handling and transportation of hazardous materials. Determine if the policies, if implemented, meet the intent of the CAIB recommendation.	Q	O10.1-1, F10.1-1, F10.1-2, F10.1-3, F10.1-4, F10.1-5
	16	Review current policies and waivers on safety factors.	D	O10.10-1
	20	Review current policy for obsolescence determination, system maintenance, and adherence to manufacturer's warranty.	D	F3.3-3
	22	Review current policy, criteria, and contractual guidance regarding supply chain, sparing, and obsolescence policy.	D	F3.8-5
	29	Develop a standard and process for anomaly identification, trending, classification, tracking, and resolution management.	D	F6.1-10
	36	Review current policies and standards for Risk Assessment to include cost, technical, and schedule risk considerations.	Q	F7.4-3, F7.4-5
	40	Review current policies and regulations on industrial safety programs.	Q	F10.4-1

Exhibit 4.1-2 (Continued). The Diaz Team 40 actions Grouped into Seven Categories.

4.2 Implementing the 40 Diaz Team actions

The approach to implementing the 40 Diaz Team actions will be performed in two phases, as follows:

1. The first phase, which resulted in this document, is the development and approval of an approach to each action by the Action Owners. This document will be the governing document for NASA to ensure that we are on track and making progress in implementing these actions effectively.
2. The second phase is the development of detailed action plans from the approved approaches described in this section. These detailed action plans will be prepared by the assigned Action Owners within 45 days of the release of this document and will exist as stand-alone plans apart from this report.

Over the course of the two phases, the implementation of each of the Diaz Team actions will follow a process shown in Exhibit 4.2-1 that includes the following steps:

- Development of detailed action plans for each action (Exhibit 4.2-2)
- Verification that each action plan leverages off and integrates with similar or related efforts that are currently underway or planned.
- Review of each action plan by the ADA/T and the EC.
- Management of the implementation of each plan to include progress review, resolution of any issues, and measurement of achievement of the results.
- Communication of implementation progress both internally and externally.

Each detailed implementation plan will conform to five basic principles:

- Each plan will use the same format.
- Each plan will be traceable back to a Diaz Team Report action and all Diaz Team actions must be planned.
- A separate approach will be developed for each Diaz Team action except where the plans are clearly complimentary. When actions are combined or consolidated, there must be clear traceability to the original actions. Action tracking will be conducted through NASA's Corrective Action Tracking System (CATS II).
- Each plan will reflect an integrated approach which leverages other ongoing and planned activities to those identified within the subject plan
- The progress and the outcomes for each Diaz Team action will be measurable and measured. Actions will be considered complete when the impact on the organization is validated through measurement.

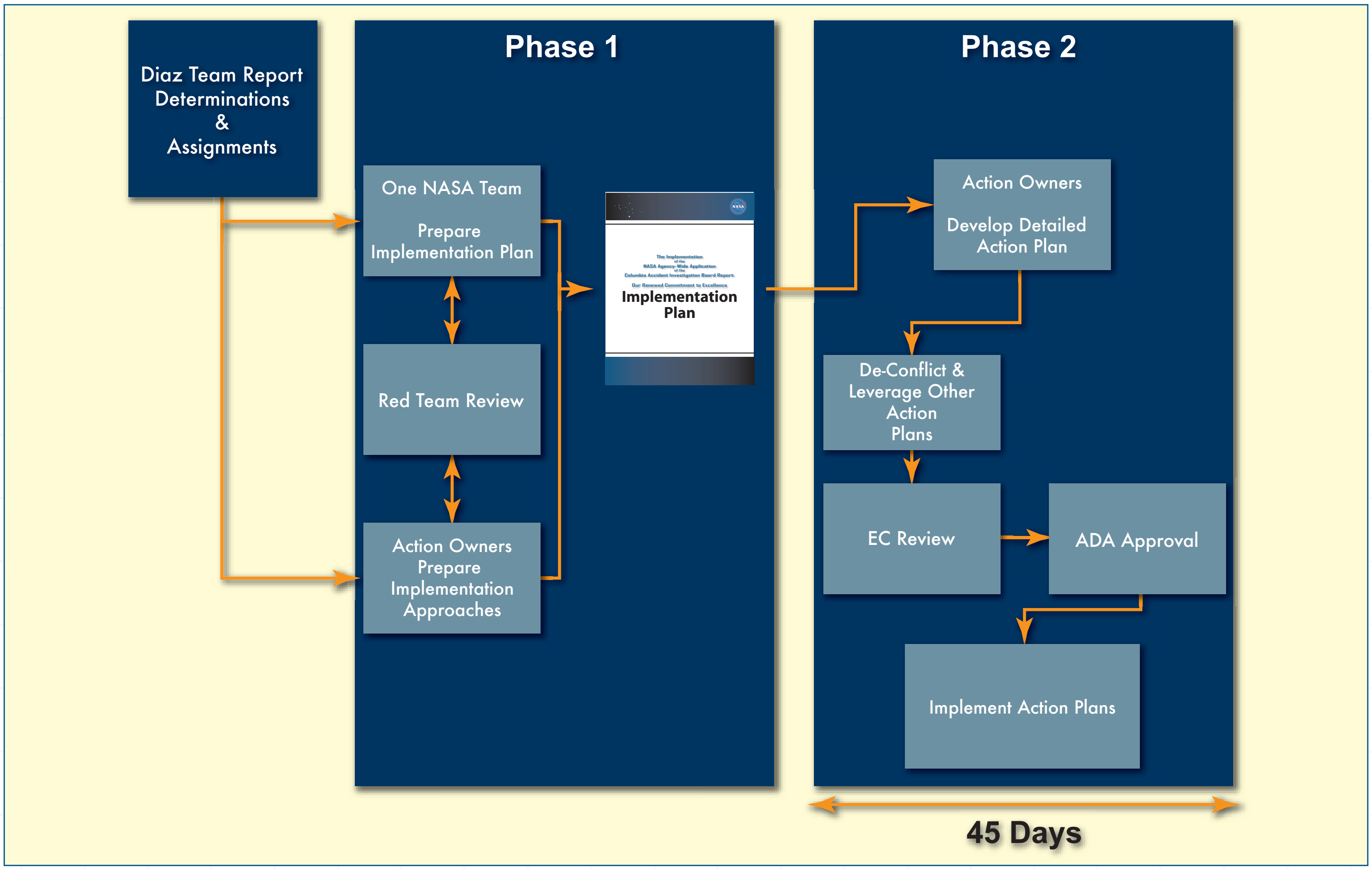


Exhibit 4.2-1. The Implementation of the Diaz Report will be done in two phases.

Action Plan	Description
Background	This section provides the context of the action.
Scope of Action and Applicable Systems, Organizations, and Functions	This section includes a matrix of program applicability in a common format.
Collaborative Requirements with Other Codes	The roles, both lead and participatory, of other NASA organizations are identified in a common matrix format.
Other Agency/Project Dependencies	Any requirements for other federal agency support or collaboration are identified.
Action Breakdown Structure	The action is described in detail with sufficient task detail.
Resources	The staffing and other associated costs for implementation.
Schedule	A schedule of milestones and actions is presented.

Exhibit 4.2-2. Detailed Action Plan Format.

4.3 Implementing the Diaz Seven Goals

In addition to the 40 actions, The Diaz Team Report identified seven goals for Agency-wide implementation, as shown in Exhibit 4.3-1.

Although the Diaz Team did not assign the accountability for planning and implementing these goals, the NASA Deputy Administrator has taken on the responsibility for their Agency-wide adoption. The Diaz Team Report did not define these seven goals as "actionable" nor provide specific implementation guidance as with the 40 actions. The approach for their implementation is that the seven goals will be implementation themes for the applicable 40 actions. This will result in their implicit adoption throughout the appropriate action plans.

The Action Manager, working for the ADA/T, will monitor action progress to ensure that the goals suffuse through the action implementations.

4.4 The Diaz Team 40 Action Plan Summaries

Sections 4.5 through 4.11 address the implementation approaches taken by the assigned Action Owners for action implementation. The Action Owner is held accountable but is provided the flexibility to address the individual or collective actions in whatever manner as long as the resultant action plans are compliant with the action requirements detailed by the Diaz Team. In many cases, this flexibility has resulted in the consolidation of specific actions along Diaz Team categories. For clarity, sections 4.5 through 4.11 provide actions correlated with the seven Diaz Team categories. For uniformity, each action summary includes the following information:

- Code / Office responsible for action implementation
- Diaz Team Action #
- Accountability
- Summary Approach
- Approach

Detailed requirements for each specific action can be found in Appendix A: Diaz Team Action Matrix.

Diaz Category	Goal
Leadership	The Agency should assess whether program management and budget formulation processes are adequate to assure there is an appropriate balance of requirements, resources, and risk to ensure safety and mission success.
Learning	The Agency should identify an appropriate approach for the future development of a knowledge management system and infrastructure to assure knowledge retention and lessons learned.
Communication	The Agency should continue the dialog that it began with the NASA workforce during Safety and Mission Success Week.
Processes and Rules	The Agency should conduct a review of its approach to maintaining and managing rules.
Technical Capability	The Agency should develop guidelines and metrics for assessing and maintaining its core competencies, including those associated with in-house work.
Organizational Structure	The Agency should complete its current NASA-wide assessment and establish independent technical authority.
Risk Management	The Agency should identify a set of risk management processes and tools which can be applied across all programs which recognize the diversity with respect to risk tolerance.

Exhibit 4.3-1. Seven Goals were listed in the Diaz Team Report.

4.5 LEADERSHIP

The Diaz Team allocated seven "Leadership" actions to three NASA Headquarters Codes for implementation. These have resulted in two individual actions for Code O and F and one consolidated action for Code D as shown in Exhibit 4.5-1.

4.5.1 Code D, Office of the Chief Engineer, Consolidated Actions

Code D has consolidated the following five Diaz Team actions into a single "Leadership" action:

- **Diaz Team Action 15:** Form a workgroup to benchmark best practices from Federal agencies (e.g., DoD, FAA, DOE) and commercial industries.
- **Diaz Team Action 28:** Develop a clear process for management chain of command and communications within a program and among government organizations and program management/contractor interfaces for anomaly request and resolution.
- **Diaz Team Action 30:** Expand upon the process for independent program reviews (Independent Assessments, Independent Implementation Reviews, and Non-Advocate Reviews) that requires re-review when any interim major milestone slips to determine the impact on mission completion schedule and cost risk.
- **Diaz Team Action 32:** Develop a clear process for management chain of command for program and workforce management.
- **Diaz Team Action 33:** Perform an assessment of best industry practices for R&D, completion, and operational programs to assess the management of schedule and cost risk through the development of management reserves.

Accountability: The implementation lead for this action will be Code D. Since the plan requirements address functions that include engineering and program/project management policy and training across all Centers and missions, Code D will collaborate closely with the Enterprises and Centers. Codes B, F, O, and Q will have contributing roles in the implementation of these actions assigned to Code D owing to the budgeting under full cost accounting, training, facilities, and risk requirements provided by the Diaz Team guidance.

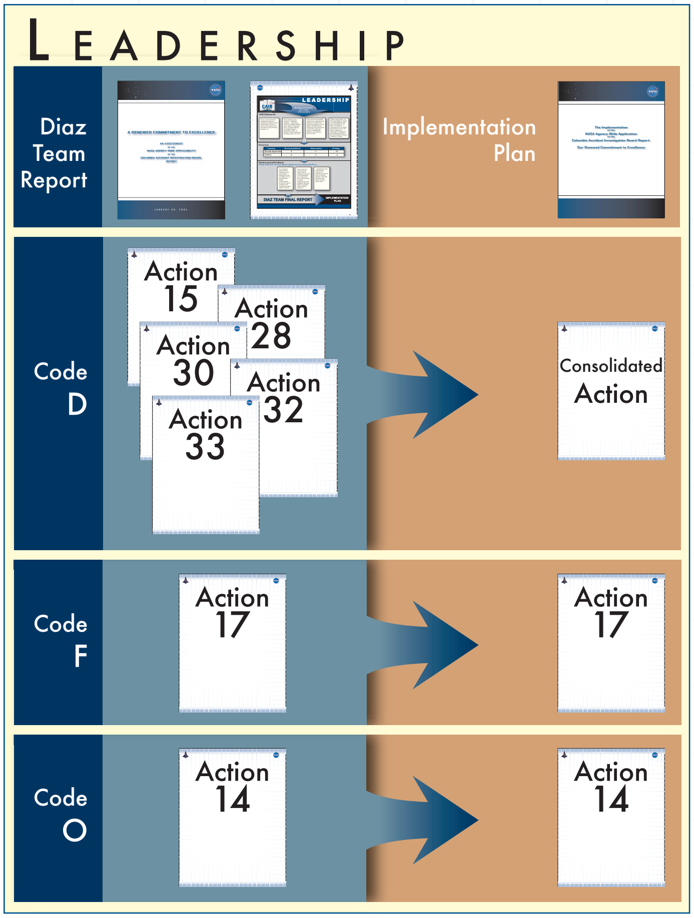


Exhibit 4.5-1. Leadership Action Mapping from the Diaz Team Report to the Implementation Approach.

Approach: Code D, The Office of the Chief Engineer (OCE), is in the process of reformatting the Program Management Council Working Group (PMCWG) to better meet the needs of the Agency. Upon the assembly and definition of this new working group, one of their first tasks will be to benchmark best leadership practices from other government agencies for possible adoption by NASA.

The NASA Program and Project Management Processes and Requirements (NPR 7120.5) document is being revised to strengthen the ways in which NASA's investments are managed. A Communication Plan is one of the new requirements that will be in the update and will require the Managers to develop an efficient and effective communication strategy. The Communication Plan will be either a part of the Program and Project Plans or attached as an appendix.

The update to NPR 7120.5 requires that Programs and Projects develop an organizational structure consistent with the program's

SUMMARY APPROACH

- Reformat the Program Management Council Working Group (PMCWG).
- Benchmark best practices from other government agencies.
- Revise NASA Policy Regulation (NPR) 7120.5 more clearly to address:
  - o Organizational structure consistent with WBS.
  - o Documenting management chain of command.
  - o Nonadvocate reviews.
  - o Program trend analyses and compliance to policy.
  - o Planning of management reserves.
- Assess the structure of engineering/technical organizations.
- Strengthen integration of policy to practice through training.

work breakdown structure (WBS). This organization structure will be capable of executing the formulation phase activities through implementation so as to meet the success criteria of the program or project. This organizational structure will document the management chain of command such that all team members and institutional leaders understand that chain. This structure shall have designated approval authorities and be documented in the Program and Project Plans.

NPR 7120.5C requires that Programs and Projects be subjected to independent reviews in the form of Non Advocate Reviews (NARs) and Pre-NAR's at scheduled intervals. These reviews will serve as approval gates for proceeding to the next phase of development. The reviews will be conducted through Code D by the Independent Program Assessment Office (IPAO) using support from the Center Systems Management Office (SMOs) and external subject matter experts as required. During program or project implementation, the IPAO will maintain surveillance and re-engage the review team if program/project metrics reveal deviations from the Project Plan. IPAO surveillance will be accomplished by planned continuous data exchanges between assigned IPAO representatives and project management; the IPAO will also attend key technical and management reviews. The independent review process currently assesses staffing and workload. Independent review results are presented to the governing Program Management Council (PMC), which includes the Agency senior leaders. These independent reviews and technical milestone reviews also assess compliance to policy, standards, and procedures. The review process is being modified to include trend analysis to identify deviations from plan and other systemic issues; these summaries will be provided to the PMC, but the process is not yet complete.

Code D has recently commissioned a study to evaluate the management of reserves. Upon completion of this study, processes and policies will be developed in the application of reserve strategies for Program and Project Management within the NPR 7120.5.

The Engineering Management Board, under the direction of the Chief Engineer, is currently assessing the structure of the engineering/technical organization and its support of programs and projects and associated communications, including those in HQs.

Code D recently initiated a review of the design/milestone review process for consistency and robustness. The results will be incorporated into policy as appropriate.

The Academy for Program and Project Leadership (APPL) and the NASA Engineering Training (NET) programs have been moved under the supervision of the Chief Engineer; this will ensure that the appropriate training classes incorporate policy and process updates, as appropriate.

Certification of program/project managers was reviewed extensively as a result of the NIAT Report. The conclusion of the PMC Working Group was that certification is not feasible or necessary. Code D will revisit this as part of the Department of Defense/Industry partnering efforts.

4.5.2 Code F, Office of Human Resources, Diaz Team Action 17: Review Current Training Strategy/Policies on Management, Leadership, and Exchange Programs Used by Government and Commercial Industry (Including NASA Contractors) for Best Practices

Accountability: The implementation lead for this action will be Code F in collaboration with the Center Human Resource Development organizations, Code D and the Enterprises.

Summary Approach

- Review current leadership and management development strategies and programs.
- Validate competencies for leadership positions.
- Benchmark programs used by other government and commercial industry.
- Conduct periodic policy reviews.

Approach: Code F will sponsor a review of current leadership and management development strategies and programs at the Agency and Center levels. This review will include the identification and validation of competencies required for various levels of NASA leadership and potential recommendations for new or improved leadership training programs. Code F will also conduct an external benchmarking effort of current training strategy/policies/programs for management, leadership, and exchange programs used by government and commercial industry.

Activities to date include:

- Collection and preliminary analysis of benchmarking data.
- Agency-wide meeting held in February 2004 with the training community and Enterprise representatives to discuss the current leadership and management career development program and to begin the development of a shared vision, roadmap, and strategy for a more consistent and integrated approach.
- Results from Agency-wide meeting were reviewed by the Management Education Program (MEP 96) class comprised of mid-level managers in March 2004. This review provided the perspective from an Agency-wide subset of middle managers, validating the concepts proposed within our plan and further expanding the work begun by the training community.

Based on review and benchmarking, NASA will develop and implement an Agency-wide strategy for leadership and management training that provides a more consistent and integrated approach to career development that identifies the skills, abilities, and experiences required for each level of advancement. The Office of Human Resources, in concert with the Code D's APPL organization, the Enterprises, and the Centers, will implement the plan in such a way that ensures that a pool of diverse candidates is developed and available for succession planning needs. Periodic policy reviews and revisions will be conducted as necessary based on regular assessments of NASA's training and leadership needs and stated indicators of the strategy's effectiveness.

4.5.3 Code O, Office of Management Systems and Facilities, Action 14: Identify Policies Associated with Workforce and Infrastructure/ Facilities Management and Obsolescence

Accountability: The implementation lead for this action will be Code O with collaboration with Code F for workforce matters; Code B/Office of the Chief Financial Officer for budgetary issues; Code Q for organizational and facility safety; Code X for facility security requirements, and each of the Enterprises and Centers.

Summary Approach

- Finalize Strategic Property Plan.
- Align requirements with capabilities.
- Validate real property inventory.
- Perform a comprehensive update to facility workforce needs and develop a process for periodic review.
- Benchmark best practices.
- Conduct Real Property Mission Analysis to seek consolidation opportunities and development of a baseline for future funding.
- Use of Integrated Asset Management System for improved planning.
- Development of metrics to relate infrastructure priorities to mission criticality.
- Integrate workforce competency determination and management with budgetary process.
- Set milestones and measures for success.
- Perform periodic audits.

Approach: The approach to this action will include an assessment of all NASA Policy Directives (NPD) and NASA Procedural Requirements (NPR) associated with facilities and workforce management. The plan is to remove ambiguity and rid the system of policies or procedures that are no longer required.

The approach will include finalizing a Strategic Real Property Plan, similar to the Strategic Human Capital Plan, so as to establish a visionary approach for managing NASA real property. Specifically, it will define management's role in aligning facilities requirements with capabilities.

Our approach will include the determination of the funding levels required for maintenance of its real property (land and all improvements including facilities). NASA will look for ways to meet the President's new vision for America's space exploration program by evaluating NASA's physical infrastructure to ensure that only essential infrastructure is retained and maintained. To that end, NASA has begun a comprehensive review of real property requirements required to support NASA mission and programs. The Real Property Mission Analysis (RPMA) will look for consolidation opportunities across the Agency and with outside organizations to reduce the requirement for real property and to set a baseline for future real property funding decisions. NASA has also begun an aggressive demolition program and a program to replace older, inefficient facilities with newer, sustainable facilities.

Our approach will also include a validation of current real property inventories; a comprehensive update to facility workforce needs and a process for periodic review; a process for continually seeking benchmarking and industry best practices for determining facility funding needs; and a continued evaluation of new tools and metrics to ensure facility operational excellence.

Specific to facilities tools, NASA will ensure its Integrated Asset Management (IAM) system will improve the Agency's infrastructure planning process. As NASA enters the formulation and blueprinting phases of IAM, NASA will ensure that the IAM system increases effectiveness and efficiency. This will reduce life cycle costs (maximizing the budget available for mission expenditures), improve data quality (allowing more informed investment decision-making), and reduce risk (asset visibility improves liability awareness).

Specific to facilities metrics, NASA will pursue using metrics that determine infrastructure priorities based on mission criticality. One such metric that will be explored is the Mission Dependency Index (MDI) developed by the Naval Facilities Engineering Service Center and the U.S. Coast Guard. The MDI is an operational risk management metric used to communicate the relative importance of a facility in terms of mission criticality. NASA has taken significant steps towards addressing this action item, as indicated in the CAIB Report Volume 2. For example, NASA has begun an annual, comprehensive, Agency-wide, fence-fence facility condition assessment and evaluation of facility repair backlog. NASA has also developed other facility metrics and models to determine facility maintenance and repair needs such as the incremental funding model of the Facility Condition Index, the Facility Sustainment Model, and the Facility Revitalization Rate. These tools and measures have replaced the old methods of collecting data from the Centers regarding backlog of maintenance and repair (BMAR) and using "rules of thumb" such as the National Research Council's recommended facility maintenance funding of 2%-4% of facility current replacement value. These tools will be continually refined and improved to provide the Agency with accurate assessment of physical plant condition and inventory.

With regard to workforce issues, the approach will examine the workforce information available to managers as well as the process for making decisions about workforce allocation. The use of new workforce planning tools (e.g., the Competency Management System and the Workforce Planning web site) will be examined and promulgated.

The approach will also include actions to ensure budgetary mechanisms are in place to adequately support facility and workforce requirements. The approach will examine the existing and potential synergy between the Competency Management System and the Agency Budget System. The Agency has begun to integrate workforce competency management and planning with the budget process. As part of the budget process, Centers will provide estimates of the competency strength needed by each program in the coming five years. These estimates will be correlated with expected attrition and used in planning for workforce intake and development. NASA recently formulated a new policy directive on strategic workforce management that lays out the requirements and a process for long-term planning to assure a flexible, capable workforce.

The approach for this action will stress continued refinement to the above actions and set milestones and measures of success. The success of the approach will be measured annually using metrics developed from the Strategic Human Capital Plan and the Strategic Real Property Plan.

Finally, the approach will accommodate a process to ensure compliance through periodic audits and reviews.

4.6 Learning

Code D has consolidated the following three Diaz Team actions into a single "Learning" action as shown in Exhibit 4.6-1.

- **Diaz Team Action 7:** Review current policies associated with developing emergency procedures and operational contingencies and associated training and certification.
- **Diaz Team Action 38:** Review current policies and standards for decision support tools.
- **Diaz Team Action 39:** Review current policies and standards for databases and knowledge sharing.

Accountability: The implementation lead for this action will be Code D who will collaborate with the CIO who has cognizance over institutional information technology services, Code F for training and knowledge retention, Code Q for review of procedures that are related to safety and mission assurance, the Enterprises who are responsible for mission funding, and Centers who are responsible for mission operations.

Summary Approach

- Assemble team to review existing emergency procedures and contingency plans.
- Develop Project Management Support website for access and assistance for decision support tools. Training to be provided through existing organizations.
- Incorporate data archive requirements and knowledge sharing processes within the 7120.5 revision.
- Develop web-based portal for engineering reference and interaction.
- Define new electronic lessons-learned system.
- Other actions already underway including database standardization and revision of NPD 3410.

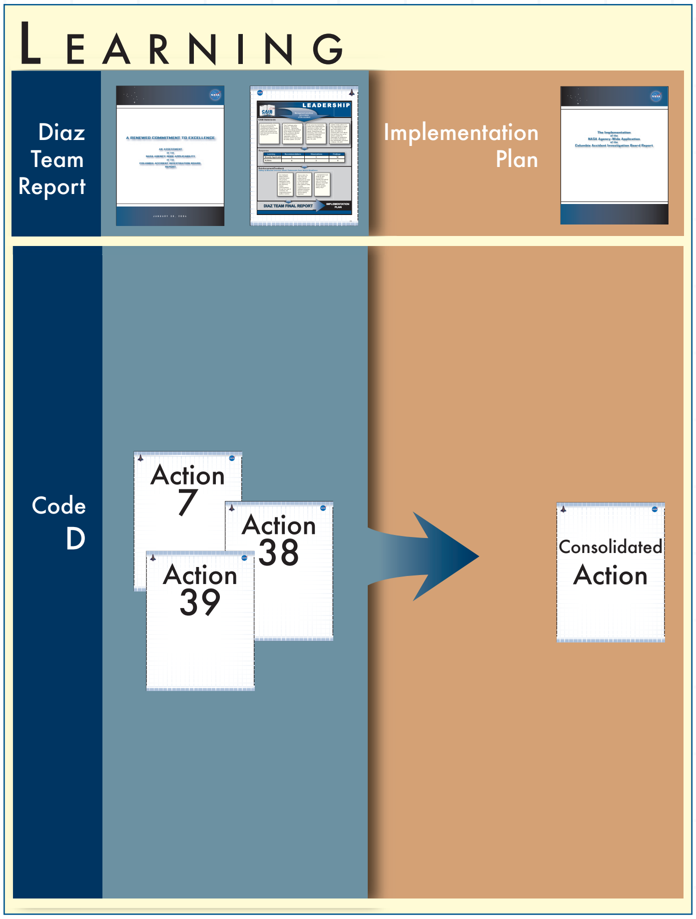


Exhibit 4.6-1. Learning Action Mapping from the Diaz Team Report to the Implementation Approach.

Approach: A cross-Agency team will be assembled to conduct a review of existing emergency procedures and contingency plans. An assessment of training and certification will also be included. Findings with regard to use and adequacy will be reported along with recommendations for improvement.

A Project Management Support website is in the early stages of development by Code D. This site will provide access and assistance with several types of decision support tools, models, and analyses for use by all NASA employees. A recent series of studies on Project Management tools will be leveraged and a special team will be assembled to determine the suite of tools for inclusion on the website.

The advancements in information technologies now enable NASA to create, capture, organize, share, and reuse Program and Project data of all types. The NASA Program and Project Management Processes and Requirements (NPR 7120.5) document is being revised to require that all programs and projects maintain electronic libraries to archive the data generated by each program and project. This will embed knowledge sharing within our work processes and enable more efficient and effective management of current and future programs and projects. Standard processes and common taxonomies will be developed for publishing data into the library. Training and assistance will be provided to the Program and Project teams in the use and maintenance of this system.

Code D has recently initiated an activity termed NEEDs – the NASA Engineering Expertise Directories. The purpose is to provide a web-based portal for engineering competencies that will include both a learning environment and access to competency-specific expertise, information, and tools. The portal will enable engineers to interact with each other and to share information within their specific competency. It will provide a learning environment; facilitate knowledge and expertise sharing; identify developmental opportunities (e.g. work details, on-the-job training); enhance communications among engineers; provide a mechanism to develop, own and manage competency-specific standards, data, and tools; and enable a search capability to find engineers with specific expertise.

NASA is in the process of defining capabilities and requirements for a new electronic lessons learned system. Data will be retrieved from numerous sources throughout the Agency, other Government agencies, and contractors. Data from the various sources can remain in the original format reducing the work for the information provider. The system will search, analyze, and present the data appropriately from any document or database type. Discipline engineering groups will determine which lessons require the incorporation into technical standards and other requirements documents. These groups will also act as a virtual resource to accommodate tacit learning.

The specific actions such as revision of NPD 3410 and the creation of a database standard for decision support tools and sharing of data are already underway. The appropriate number and type of projects will be assessed as detailed implementation progresses.

Training and development assistance will be provided on decision support tools through APPL and the Site for On-line Learning and Resources (SOLAR), community workshops, and NET. Also, tools, standards, and training will be integrated into NASA systems and procedures.

4.7 Communication

Code D has consolidated two Diaz Team actions into a single "Communication" action as shown in Exhibit 4.7-1. These are listed as follows:

- **Diaz Team Action 24:** Identify clear chains of command in a program including responsibility, accountability, and authority for issue communications.
- **Diaz Team Action 35:** Review communications policies and reports. The review will focus on the requirements for formal reporting during normal and emergency/crisis times. For formal reporting during normal operating tempo, the frequency of the reports shall be determined, and who produces/reviews and approves these reports.

Accountability: The implementation lead for this action will be Code D however; all organizations within the Agency, including the Administrator and especially the Centers are essential for full accomplishment.

Summary Approach

- Modify NPR 7120.5 to reflect investment management practices and communications strategies.
- Revise NPR 7120.5 to address:
  - o Organizational structure consistent with WBS
  - o Documenting management chain of command
- Revise Strategic Management Handbook, NPR 1000.2 to define current NASA management structure.
- Review policies across NASA on nominal and emergency reporting.
- Pursue improvements in communications across NASA.
- Improve the robustness and consistency of the anomaly resolution process by reviewing and revising current procedures.

Approach: The NASA Program and Project Management Processes and Requirements (NPR 7120.5) document is being revised to strengthen the ways in which NASA's investments are managed. A Communication Plan is one of the new requirements that will be in the update and will require the Managers to develop an efficient and effective communication strategy. The Communication Plan will be either a part of the Program and Project Plans or attached as an appendix.

The update to NPR 7120.5 requires that Programs and Projects develop an organizational structure consistent with the program's work breakdown structure (WBS). This organization structure will be capable of executing the formulation phase activities through implementation so as to meet the success criteria of the program or project. This organizational structure will document the management chain of command such that all team members and institutional leaders understand that chain. This structure shall have designated approval authority and be documented in the Program and Project Plans.

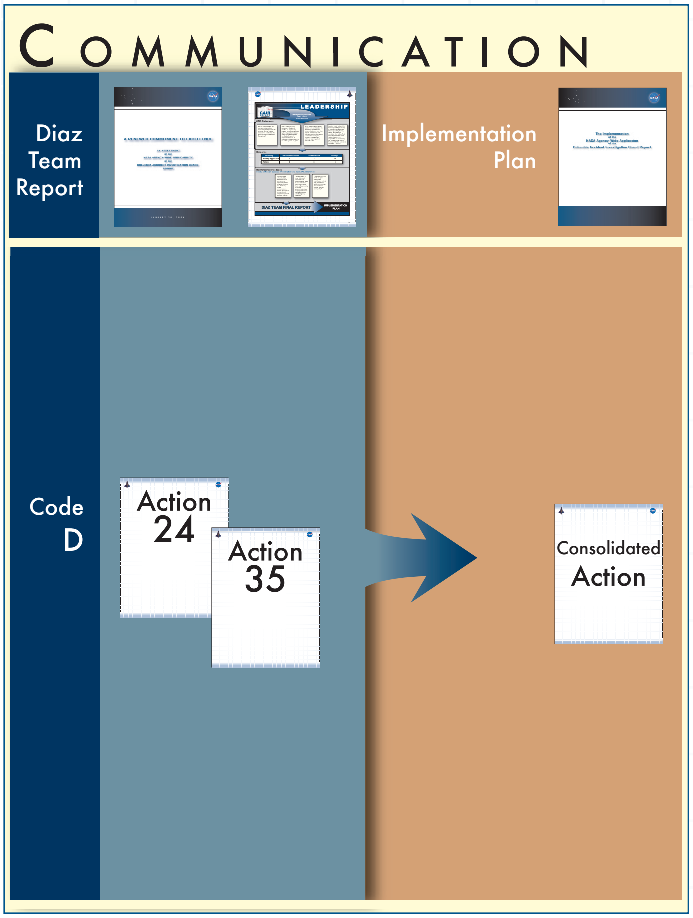


Exhibit 4.7-1. Communications Action Mapping from the Diaz Team Report to the Implementation Approach.

An assessment of the Agency's structure and reporting chains within our program management chain of command is currently underway by the Roles, Responsibilities, and Structures team. The NASA Strategic Management Handbook, NPR 1000.2, is being revised to clearly define the current management structure of the Agency and will incorporate the results of this assessment. This document will be submitted to the NASA Online Directives Information System (NODIS) release system for review and approval in the Spring of 2004.

The NASA Office of the Administrator, Enterprises, Functional Offices, and Field Centers all have different reporting policies to meet their various management needs. A review of the policies will include content, frequency, emergency periods, reviewers, and approval authority and will allow for adjustments as necessary for improved effectiveness and efficiency.

Engineering is one of the most obvious places where we can benefit from a One NASA approach from the standpoint of communication and collaboration, but it is also one with the largest inertia. Code D will pursue several improvements in communication and collaboration including:

- **Headquarters**. There is too little communication between Headquarters and the Field on technical matters. There has been too little Headquarters involvement, due to restricted resources, in actually developing and implementing the improvements previously and currently identified as necessary.
- **Code D and Center Engineering Organizations.** Code D will receive periodic reports and informal briefings from the Center Engineering Organizations. Code D will distribute information at Headquarters, as appropriate, for information, discussion, and decisions.
- **Center Engineering.** The Center Engineering Director will receive periodic briefings from the Lead Engineers who are matrixed to programs and projects.
- **Report Distribution.** Summary reports of reviews and audits will be widely distributed to ensure that the relevant organizations and individuals are kept involved.
- **Emergency Reporting.** Emergency procedures will be reviewed and revised, if necessary, to ensure that communications are event timely, to the proper individuals, with timely decisions. Alternate communications paths for conflict resolution will also be established.

Code D will improve the robustness and consistency of the anomaly resolution process by reviewing current procedures and revising as necessary.

4.8 Processes and Rules

Seven actions were allocated to Processes and Rules in the Diaz Team Report. These were assigned to three codes of which five have been consolidated into a single Code D action and the remaining two addressed by Codes Q and X as shown in Exhibit 4.8-1.

4.8.1 Code D, Office of the Chief Engineer, Consolidated Action

Code D has consolidated the following five Diaz Team actions into a single "Processes and Rules" action:

- **Diaz Team Action 1:** Review/develop current policy or guidance that assures critical event data are collected, observed, and analyzed.
- **Diaz Team Action 2:** Develop a standard for comprehensive program risk management and observable data collection for all phases of program development, test, operation, and enhancement to be used for program management, improvement, anomaly/disaster reconstruction.
- **Diaz Team Action 12:** Review current initiatives for International Standards Organization (ISO) and Software Engineering Institute Capabilities Maturity Model (SEI CMM) across the agency to determine if they are meeting the objectives of NASA and are cost and operationally effective.
- **Diaz Team Action 13:** Review current policies, program, and technical documentation audits across NASA. Determine if the policies, if implemented, meet the intent of the CAIB recommendation.

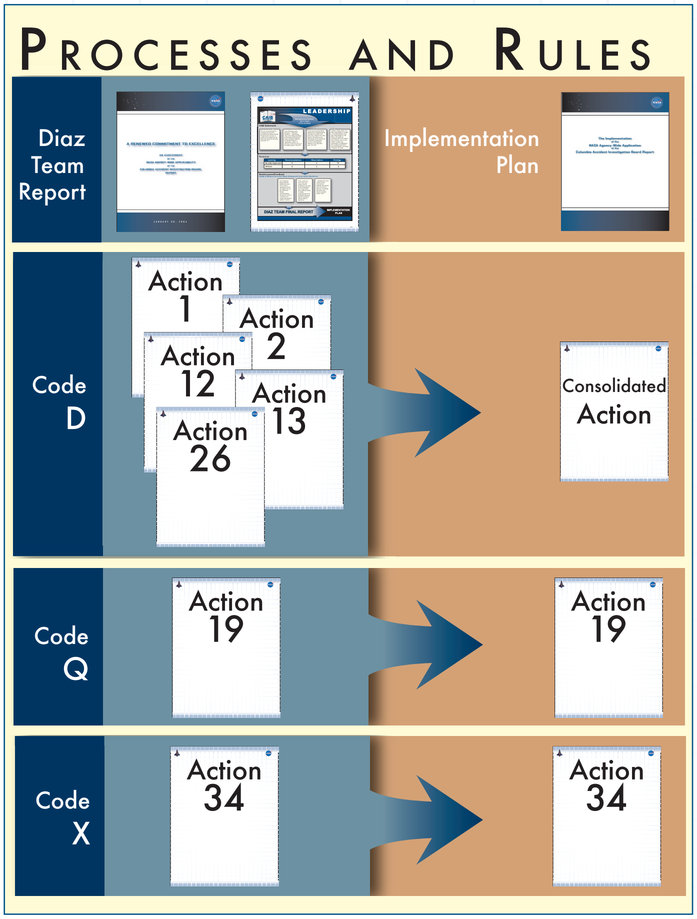


Exhibit 4.8-1. Processes and Rules Action Mapping from the Diaz Team Report to the Implementation Approach.

- **Diaz Team Action 26:** Review a minimum of three programs to determine if they are "Following the Rules."

Accountability: The implementation lead for this action will be Code D with collaboration from the Center engineering and S&MA organizations, the Enterprises, and Code Q.

Approach: Engineering policies are currently being reviewed by Code D, and, with support and advice of the Engineering Management Board (EMB), an assessment is being made to determine whether an agency engineering NPR is necessary to establish consistent expectations for all phases of a program and project lifecycle. If determined necessary, this NPR would clearly distinguish between R&D, R&T, operational programs, and projects. Compliance will be ensured through technical reviews, independent assessments, and technical audits.

Several themes resonate throughout the Diaz and CAIB Reports. They include:

- Engineering Processes
- Performance Verification and Validation
- Closeouts

Summary Approach

- Determine if NPR is necessary.
- Assess whether policies, processes, and procedures are adequate and revise as appropriate.
- Revise NPR 7120.5 to provide guidance on compliance documentation.
- Identify a process to address methods for the acquisition, storage, and analysis of critical mission and operations data; develop NPR to establish policy, standards, and processes including the requirement for periodic independent program reviews and assessment.
- Inventory ISO, CMM/CMMI, and Continuous Risk Management (CRM) usage across the Agency; assess areas of strengths and weaknesses and update policy, training materials, fund transition plans, and check compliance across the Agency.
- Institute a continuous improvement initiative out of the Office of Chief Engineer for "mission-critical management positions" that utilizes best practices from government and industry.
- Coordinate periodic program audits requirements with Headquarter organizations to reduce the burden on programs and projects.

- Configuration Control
- Technical Reviews and Audits
- Engineering Tools
- Engineering Drawings
- Requirements Review and Flow-down

The ongoing policy review that includes policies, processes, and procedures identified in the Reports will be assessed for adequacy, and revised as appropriate.

The NASA Program and Project Management Processes and Requirements (NPR 7120.5) document is currently being revised to strengthen the way in which we manage NASA's investments. For each requirement in the document, evidence of compliance will be required. This new process will provide NASA management with the visibility to ensure that programs and projects are "following the rules" along with the requirements that must be verified for their particular program or project.

This action applies to all NASA programs and projects and requires access to critical data at various points within the life cycle. One example includes the requirement for closeout photographs of key assemblies during the manufacturing process and the routine capture and analysis of specific system parameters during operation. The requirement to consider the need for critical data applies to all systems and includes methods for the acquisition, storage, and analysis of the data. This approach will provide consideration of the broadest scope of circumstances – from critical situations demanding real-time sampling and assessment to systems that are considered safe and secure but should be documented for future, unforeseen needs.

Specific initiatives, although not comprehensive, include:

1. Compare the steps of this action with those of other Diaz Team actions to ensure the management of risk is not being addressed in multiple or conflicting ways.
2. Conduct a literature search through existing policies and directives.
   2.1. Find similar standards/processes that may already exist in NASA.
   2.2. Find similar standards/processes in the literature for analogous technology outside of NASA.
3. Collect additional data, as needed, from respective standards/process owners.
4. Analyze the data and identify advantages and disadvantages of various standards/processes.
5. Synthesize new or modified standards/processes for observable data identification, collection, and assessment in NASA.
   5.1. Prepare white paper on "Critical Event Data Management".
   5.2. Coordinate white paper with interested NASA parties and disposition comments, making appropriate changes to white paper.
6. Develop NPR to establish policy, standards, and processes. Include the requirement for periodic independent program review and assessment that validates risk areas and comprehensive monitoring/management based on this standard.

The focus of this approach is to address processes associated with the acquisition and management of critical event data and documentation. This approach identifies the activities associated with technical data acquisition and management as well as the appropriate management certification processes to ensure practice consistency. From the standpoint of ISO and SEI CMM, NASA has taken the following actions:

- **ISO**. ISO is a broad spectrum implementation standard with an emphasis on the areas of; Management Responsibility, Resources Management, Product Realization, Measurement, Analysis and Improvement, and has a Customer Focus. In 1999, all of NASA Headquarters, Centers and the Jet Propulsion achieved ISO 9001 registration. With this achievement, NASA became the first Government Agency to have multiple sites under an ISO 9001 registration. In coordination with the Freedom to Manage task force, NASA made a change to their Management System Policy requiring ISO 9001 registration. The rationale for this change was the need for management systems that provide rigor and discipline and flexibility to accommodate a full range of risk management. It is no longer mandated that all NASA Centers and Headquarters be certified to the ISO 9001 standard, but rather an updated NPD 1280.1 requires that NASA management systems meet a set of minimum criteria. The policy states that ISO 9001 or AS 9100 may be used to satisfy the policy, as well as additional approaches, where approved by the Deputy Administrator.
- **CMM/CMMI**. The Capability Maturity Model (CMM) and Capability Maturity Model-Integrated (CMMI) developed under DoD by the Software Engineering Institute at Carnegie Mellon contain the essential elements of effective processes for one or more disciplines, which are used to appraise organizations' capability to produce products. The specific disciplines covered under CMM/CMMI are; Software Engineering, Systems Engineering, Acquisition, and Integrated Product and Process Development. NASA NPD 2820.1 requires providers to demonstrate their organizational capabilities and experience to deliver quality software on time and within budget and requires acceptable evidence of the entity's software management, engineering, and assurance standards, processes, and practices to produce quality software. A CMM/CMMI level rating of 3 or higher is acceptable evidence to comply with this requirement. In 2002, Code D began using CMM/CMMI as a benchmark to objectively measure Center progress toward software improvement through the Software Engineering Initiative. In 2004, NASA's Code D began piloting the use of CMMI-SE to assess systems engineering capability across Centers.

Our approach is based on these initial actions taken by the Agency and includes:

1. Inventory of ISO, CMM/CMMI, and CRM usage and estimated cost across the Agency.
2. Survey of the pros and cons by Agency users of ISO, CMM/CMMI, and CRM.
3. Benchmark NASA's usage of ISO, CMM/CMMI,

and CRM against aerospace industry and government partners including a benchmark of best practices and cultures of continuous improvement explicitly for "mission-critical management positions."

4. Collect sample cost and effectiveness measures on existing NASA usages of ISO, CMM/CMMI and CRM to determine whether modifications to current NASA policy are warranted.
5. Identify areas of Agency weakness where ISO, CMM/CMMI, CRM or standards can strengthen management and/or engineering. Also identify areas where the policy should not be applied.
6. Using the information gained from steps 1 – 5, update policy, training materials, fund transition plans, and check compliance across the Agency.
7. Institute a continuous improvement initiative out of Code D for "mission-critical management positions" that utilizes best practices from government and industry. This initiative will emphasize the important skill set needed to enhanced program/project decision-making during planning, development, operations, and maintenance.

Numerous Diaz actions required the audit or assessment of programs and projects. The plan is to combine as many assessments as possible to reduce the burden on projects, technical organizations and the assessment teams.

4.8.2 Code Q, Office of Safety and Mission Assurance, Diaz Team Action 19: Review procedures for anomaly identification and characterization.

Accountability: Code Q will provide the lead for this action in combination with Code D's action number 29. Code Q, Code D, and NESC will work in close collaboration on the combined actions.

SUMMARY APPROACH

- Develop requirements in close coordination with Code D and NESC on Action 29.
- Establish failure disposition processes within Agency.
- Review and consider reinstituting post-*Challenger* policies and processes for problem reporting and trend analysis.
- Rely on guidance for Root Cause Analysis issued by Codes Q and D.

Approach: Code Q, Code D, and NESC will develop requirements that will address this cited deficiency in close collaboration. Field center SMA and engineering directors will be consulted as requirements are formulated. As a first step, we will endeavor to establish how failures are disposed by organizations in the Agency. It will most likely be necessary to establish a centralized set of requirements to guide the Agency so that we are dispositioning problems in a common framework. One approach that is under consideration is to reinstate requirements that were developed during the first few years after *Challenger*, but were eliminated during the mid-1990s to reduce the burden of requirements that were said to be stymieing innovation and efficiency. We will draw heavily on post-Challenger requirements for problem reporting and trend analysis, which were extensively coordinated throughout the Agency in the late 1980s. We will review the policy, procedural, standards, and guidance documents from that era to determine their applicability and potential for updating and reinstatement. Code Q will also rely heavily on recently released guidance on Root Cause Analysis issued jointly by Codes Q and D. Code Q and Code D will consider the draft NPR for NASA Engineering, currently under development as the requirements to incorporate new or updated policy and procedural requirements for the identification, tracking, and disposition of problems, anomalies, and failures. This will provide a central set of core requirements for all elements of the Agency to follow.

4.8.3 Code X, Security, Diaz Team Action 34: Determine if NASA needs a Central Source for Maintaining Security Clearances

Accountability: Code X is the lead organization for this action and will coordinate with the Enterprises, Centers, Program Management, and Code F to ensure that succession planning is consistent with access requirements.

SUMMARY APPROACH

- Put in place Central Adjudication Facility for centralized management of personnel security actions.
- Updated NPR 1620.1B to reflect new requirements and procedures.
- Drafted new NPR 1600.1 with guidance for program managers on managing staff security requirements.
- Coordinate an audit with all the Enterprises on security and access requirements for NASA programs.
- Require and support annual reassessments of program access posture.

Approach: Prior to the *Columbia* tragedy, the Office of Security Management and Safeguards, Code X, recognized that there were problems with the existing personnel security clearance management system. After a thorough review, Code X implemented several organizational and process changes designed to more efficiently manage the program, more effectively identify Agency requirements, and adhere to National level policies. The following actions have taken place to date:

- NASA Office of Security Management and Safeguards, Code X, has established a Central Adjudication Facility at the HQ level tasked with centrally managing all NASA personnel security actions. Security Clearances are granted, denied, and revoked only at this activity. The Clearance Verification System (CVS), the NASA data-base representing personal information on all NASA clearance holders, is in place and available for Center Security Officials to refer to for clearance status.
- Chapter 2 (Personnel Security) of the current NASA

Security Program Procedural Requirements (NPR 1620.1B) has been updated to reflect new requirements and procedures.
- A new NPR (1600.1), NASA Security Program Procedural Requirements, has been drafted. Chapter 2 (Personnel Security Program Requirements and Investigations for Positions Requiring Access to Classified National Security Information (CNSI) has been expanded to ensure program managers are aware of their responsibilities in managing personnel security clearance requirements for program personnel. Anticipated publication date is late Spring 2004.
- Aggressive activity has been implemented to ensure current clearance needs for Return to Flight are anticipated and appropriate clearances are obtained in a timely manner.

Code X will coordinate with the Enterprises to conduct a comprehensive audit of security clearance and access requirements for NASA programs. The audit will assess and align participants' (managerial and operational) level of clearance with program requirements and needs for daily as well as contingency operations. The audit will be accomplished in the following manner under an established schedule:

- Action #1: Code X will integrate the names and level of access from the NASA Sensitive Compartmented Information (SCI) database into the NASA database for collateral security clearances.
- Action #2: Code X will produce a run of all NASA employees, by Center, listing the individual's name, status (Civil Servant, Contractor) level of security clearance, and related SCI compartments.
- Action #3: The clearance report will be forwarded to each Enterprise for distribution to Enterprise program managers.
- Action #4: Center Security Offices will conduct training on security clearance management requirements and processes to program management and Human Resources (HR) personnel. Training will be on an annual basis and may be conducted using web-based training methods.
- Action #5: Each program manager, in coordination with their respective Center personnel security activity, will assess the access needs for each program participant, compare the assessment with the access level identified in the report; and annotate whether or not a change in access is required to support program operations. Position Descriptions and Position Sensitivity Designations, including designation as a "Testing Designated Position (TDP)" for TOP SECRET and above, will be updated in coordination with Center HR Offices. "Cleared" personnel will be entered into the Agency and Center Random Drug Testing Pool. This is a continuous activity.
- Action #6: Program managers will assess the access requirements for contractor personnel supporting programs, including the requirement for participation in the contractor's drug testing program for contractor personnel positions designated TOP SECRET or above, and will request any adjustment to the contract or contractors via normal contract procedures, to include generation of a DD Form 254, "Department of Defense Contract Security Classification Specification." Contract adjustments will be annotated in the audit document. This is a continuous activity.
- Action #7: The Enterprise AA, or designee, will review and concur with program security clearance needs prior to returning their portion of the audit to Code X.
- Action #8: The Enterprises will be responsible for ensuring that program managers initiate the paperwork to effect any changes required, to include ensuring individual position descriptions reflect the requirement for accessing classified information at the required level, the appropriate position sensitivity designation, and inclusion as a "Testing Designated Position," for TOP SECRET and above. This is an ongoing requirement.
- Action #9: Once the audit establishes the base line for individual access for program participants, program managers, through the Enterprises will be responsible for maintaining their program access posture in accordance with Chapter 2, NPR 1620.1, and its successor document Chapter 2, NPR 1600.1, scheduled for publication late Spring 2004.

Code X will also require and support annual reassessments of program access posture.

4.9 Technical Capabilities

Six Diaz Team actions were initially allocated to Codes D and H. Five actions have been consolidated for Code D with a single remaining action to Code H as shown in Exhibit 4.9-1.

4.9.1 Code D, Office of the Chief Engineer, Consolidated Action

Code D has consolidated the following five Diaz Team actions into a single "Technical Capabilities" action:

- **Diaz Team Action 4:** Develop a standard for the development, documentation, and operation of models and simulations.
- **Diaz Team Action 10:** Review current policies and capabilities associated with configuration control, closeout photographs, and engineering drawings. Determine if the policies, if implemented, meet the intent of the CAIB recommendation.
- **Diaz Team Action 21:** Identify methods used by other test organizations to perform remote system testing and anomaly resolution.
- **Diaz Team Action 23:** Develop a standard for the modeling and testing (both destructive and nondestructive) of system components and assemblies.
- **Diaz Team Action 25:** Identify programs of similar nature with applicable practices for such activities as closeout photographs, program documentation, and configuration management to NASA operational and R&D initiatives.

Accountability: The implementation lead for this action will be Code D with collaboration from the Center engineering and S&MA organizations, the Enterprises, and Code Q. Collaboration with Code H will also be required for contractual issues.

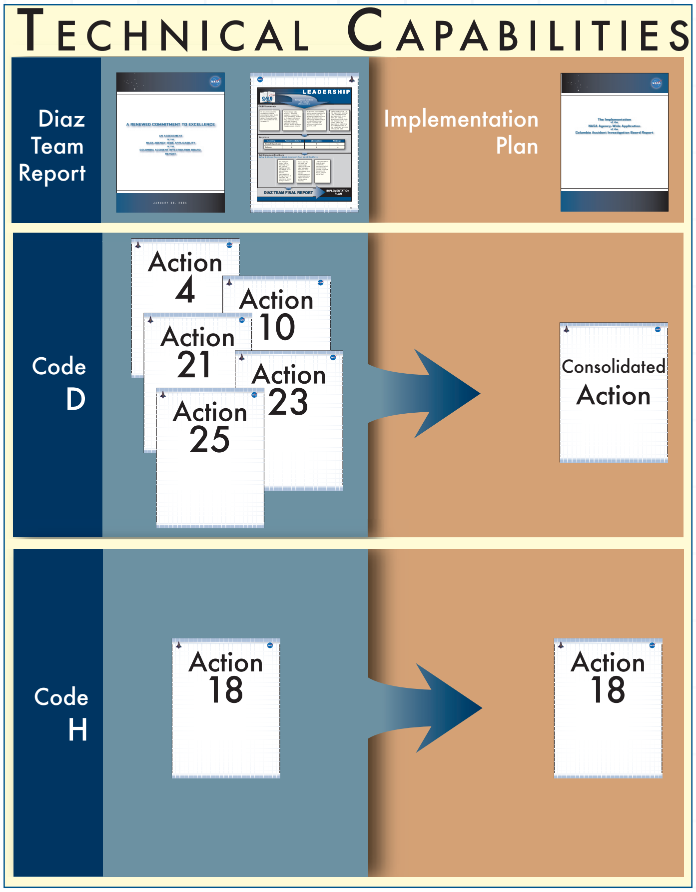


Exhibit 4.9-1. Technical Capabilities Action Mapping from the Diaz Team Report to the Implementation Approach.

Summary Approach

- Identify and review Agency policies, conduct audits, compile results/final report, and rewrite policies for documenting closeout and as-built configurations.
- Create a team consisting of representatives from Code D, JSC, DFRC, GSFC and JPL to identify shortfalls in communications protocols, escalation procedures, and information integration for anomaly resolution.
- Coordinate with Action 35 for communications benchmarking activities associated with remote testing and anomaly resolution.
- Synthesize a set of best practices and recommend changes as appropriate. Communications best practices gleaned from the benchmarking activity will be forwarded to the Diaz Action 24 Implementation Team for coordination.
- Develop a modeling and test standard.

Approach: The CAIB observed that NASA practices for documenting closeouts and as-built configuration were not consistent and that the information which exists is not managed in a way that allows ready recall of the information required to influence in-flight decisions. Code D will identify programs of similar nature with applicable practices for such activities as closeout photographs, program documentation, and configuration management to NASA operational and R&D initiatives. The Plan is to identify and review Agency policies, conduct audits, compile results/final report, and rewrite policies. This activity impacts all Agency programs/projects that process flight hardware and associated GSE including NASA contractors and their suppliers. This activity will standardize the way we document the as-built configuration of flight hardware and ground support equipment. Specifically, it will define Agency-wide requirements for closeout photographs and practices for assuring as-built configuration information is available to support in-flight decisions. This activity affects the entire NASA-contractor community and will directly impact future contracts.

The CAIB Report states that image analysis of *Columbia*'s launch was hampered by the lack of adequate high-speed cameras suited to the task. The available equipment was often non-operational or out of focus and located in sub-optimal locations. The report further states that a developmental vehicle should be equipped with high-resolution cameras that monitor potential hazard areas and that critical information from these systems needs to be downlinked so that potential problems are identified as soon as possible.

Despite the lack of optimal imaging equipment, the CAIB found that information concerning the foam separation and impact on *Columbia*'s left wing was available during the mission and was adequate to determine the effects of the foam hit on the thermal protection system. The CAIB Report discusses shortfalls in communications protocols, escalation procedures, and information integration that inhibited anomaly resolution.

The implications of this CAIB finding extend far beyond the Shuttle accident to many areas of NASA activities ranging from flight testing of aircraft to on-board satellite system status to instrumentation of ground based test facilities. Issues related to communications are particularly generic and of extreme importance.

An implementation team will be constituted consisting of representatives from Code D, JSC, DFRC, GSFC and JPL; each representative fulfilling specific roles. The Code D representative will lead this team, given the overall Agency impact. JSC is chosen due to the specific and significant applicability of this action to manned space flight. DFRC is chosen due to the specific applicability of this action to aeronautic developmental vehicles. GSFC's involvement will be in the area of remote testing associated with sounding rocket, balloon vehicles, and launch range support. JPL will provide insight associated with space systems diagnostics. Other Centers will be involved from a benchmarking perspective.

Return to Flight activities will address specific Shuttle-related issues with regard to remote sensing and communication requirements related to this action. The implementation team will closely follow these developments, contribute to them as appropriate, and capture the improvement initiatives in terms applicable to the Agency's broader mission base.

With regard to the communications aspect of this action, there are several other Diaz Team actions that cover the same issues in whole or in part. Notably, Action 24 deals specifically with many of the communications issues raised in Action 21. Action 21 does involve benchmarking, which is not specifically discussed in Action 24, but the context of this benchmarking is fairly narrow. Action 35 involves an audit of communications practices, which could, with proper coordination, fulfill the requirement for benchmarking communications processes required by Action 21. Implementation teams working these actions (and others which contain elements relating to communications such as Actions 19, 23, and 28) will closely coordinate their activities to preclude duplication of efforts.

The implementation team will take the information received through benchmarking and, for requirements definition and communications practices synthesize the information into a set of best practices. For requirements definition, the team will compare the benchmarked best practices related to remote testing with what we currently do, and recommend changes as appropriate. Communications best practices gleaned from the benchmarking activity will be forwarded to the Diaz Action 24 Implementation Team for inclusion in their work.

For the technology element, the more formal capturing of technology limitations has two uses. The most obvious is highlighting to the technologists the scope and impact of these limitations on remote testing. The second is a bit subtler. Current technology limitations could impact the definition of data requirements as well as impact the decision-making process (e.g. people often make decisions thinking the data is better than it really is). One of the established benchmarking questions or some variant would help the implementation team start this assessment.

The big emphasis in Action 23 is to ensure that the analysis of previous test results and operational experience (trending) is factored into future testing and qualification of components, subsystems, and systems in a systemic way. Benchmarking is a key factor in addressing this action and this benchmarking should begin with NASA Centers and JPL to understand current practices around the Agency. From this experience, benchmarking procedures should be refined and benchmarking should continue with DOD and industry.

Out of the benchmarking would come a set of identified best practices, and from those best practices the implementation team would develop the recommended process for test design and subsequent test article verification, validation, etc. Trending of data and the subsequent effective analysis and use of trended data seems to be a weakness at many of our Centers and this first step will better qualify this issue and define contributing causes.

Other actions identified in the Diaz Report contain elements that are similar in nature to elements of Action 23. Actions 3, 20 and 22 all reference supply chain management. Action 18 involves development of standards for acceptance testing and performance verification of contractor-provided material. Action 24 as well as 19, 23, 28, and 35 all involve improving communications. The implementation team for Action 23 will work closely with these other teams as action plans are finalized to minimize duplication of effort. Code D leadership will ensure that this coordination takes place effectively.

Code D has several initiatives underway to improve technical capabilities and competency. The Advanced Engineering Environment is in early formulation and will provide technical tools that will improve accuracy, efficiency, and collaboration. Code D, with support from the EMB, is continually evaluating new tools for deployment at the Centers and contractors. These tools are generally proposed by a Center, and the Engineering Management Board evaluates the benefit versus impact to implement.

Code D is collaborating with the Office of Safety and Mission Assurance (OSMA) and the nondestructive evaluation organization at LaRC to improve NDE techniques and integrate them into the development and test process.

Code D will review and revise, if necessary, the policies/requirements and capabilities for configuration control, closeout photographs, and engineering drawings. We will ensure that the "as designed" is equal to the "as built", and the state of the system is known after launch/deployment. Of course, Code D will evaluate the available tools and techniques for best practices.

A modeling and test standard will be developed.

4.9.2 Code H, Procurement, Diaz Team Action 18: Review Current Policy, Criteria, and Contractual Guidance Regarding Government Acceptance

Accountability: Code H will take the lead in coordinating the review of this action and will coordinate appropriate activities with Code D, Code Q, the Enterprises, the Centers, and the NESC at LaRC.

Summary Approach

- Review policies associated with acceptance of contracted systems.
- Coordinate with the NESC at LaRC and Code D and solicit ideas from Centers.
- Assess best practices from other federal agencies for applicability to and potential adoption by NASA.
- Define a policy for periodic program reviews, compliance assessments, and effectiveness.

Approach: The implementation approach for this action requires direct contractual traceability from program requirements to the contracts for the delivery of systems, subsystems, and components. Clear acceptance criteria will be established that ensures contractual compliance with requirements.

The approach to this action will begin with a review of policies regarding the acceptance of contracted systems. Initial action will require a review of all rules, regulations, and guidance relating to inspection and acceptance of products. A small, internal team, including the Office of Procurement, Office of the Chief Engineer, Office of Safety and Mission Assurance and the Enterprises will be formed to review program requirements and to ensure testing methodologies to determine that design requirements are met and are in fact in place. The team will then be expanded to include some outside agencies. This will take into consideration the Federal Acquisition Regulations (FAR) and NASA FAR Supplement as well as any internal policies or guidelines such as existing NPGs and NPDs to determine if there are provisions for non-destructive testing. The approach will require coordination with the NESC at LaRC and Code D. The approach will also solicit ideas from the Centers. Additionally, we will contact other agencies and ask to review any internal testing methodologies they may have to see if they can be useful for NASA.

To ensure this problem does not recur, we will also define a policy for periodic program reviews and compliance assessments as well as assessments on policy effectiveness with the appropriate process for review and revision as required.

4.10 Organizational Structure

Four "Organizational Structure" actions were developed in the Diaz Team Report and assigned to Codes D and Q. Three have been consolidated into a single Code D action as shown in Exhibit 4.10-1.

4.10.1 Code D, Office of the Chief Engineer, Consolidated Action

Code D has consolidated the following three Diaz Team actions into a single "Organizational Structure" action:

- **Diaz Team Action 27:** Develop a standard and process for independent review of all program requirements and operational constraints for consistency and identify all program waivers.
- **Diaz Team Action 31:** Perform a comprehensive assessment of major program interdependencies.
- **Diaz Team Action 37:** Review current policies and standards from an organizational structure and responsibility perspective.

Accountability: The implementation lead for this action will be Code D with collaboration from the Office of the Space Architect, Center Engineering and S&MA organizations, the Enterprises, Code Q, and the NESC.

Summary Approach

- Revise NPR 7120.5 to address:
  - o Organizational structure consistent with WBS.
  - o Documenting management chain of command.
  - o Designate approval authorities.
  - o Provide for non advocate reviews.
- Coordinate with Space Architect to continually assess the interdependencies of programs and projects.
- Develop a matrix engineering approach and management infrastructure across NASA for more effective engineering, cost, and schedule management.
- Utilize the NESC for more effective program insight.

Approach: The update to NPR 7120.5 requires that Programs and Projects develop an organizational structure consistent with the program's work breakdown structure. This organization structure will be capable of executing the formulation phase activities through implementation to meet the success criteria of the program or project. This organizational structure will document the management chain of command such that team members and institutional leaders understand that chain. This structure will have designated approval authorities and be documented in the Program and Project Plans.

A balance between engineering, program and project management, and an independent arm such as safety and mission assurance, must be developed to provide the checks and balances common to successful management practices. Independent reviews will provide the opportunity for the projects to be evaluated by experts that may be able to identify issues and possible solutions.

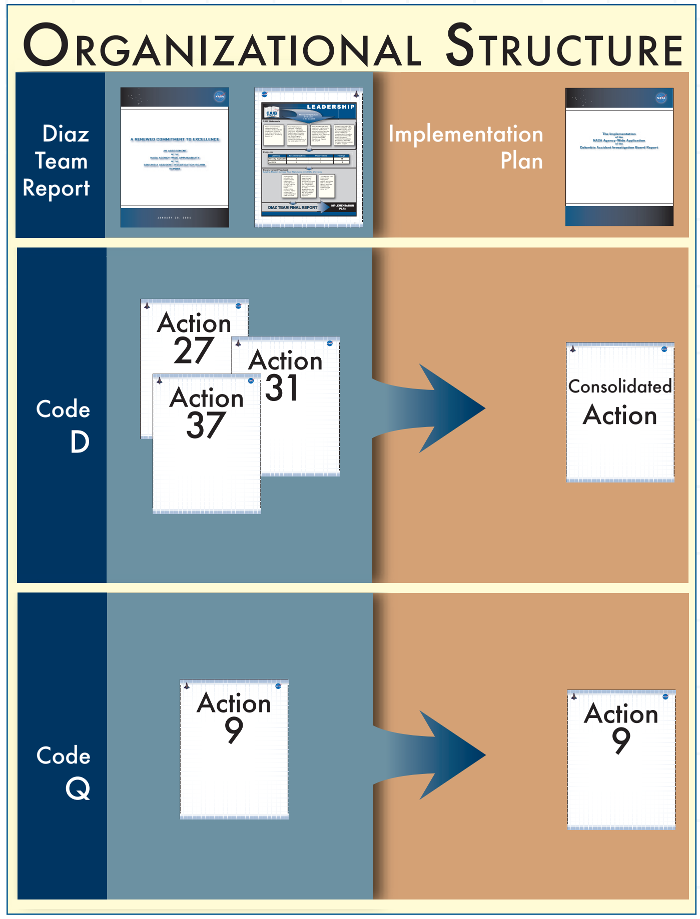


Exhibit 4.10-1. Organizational Structure Action Mapping from the Diaz Team Report to the Implementation Approach.

NPR 7120.5C requires that Programs and Projects be subjected to independent reviews in the form of Non Advocate Reviews (NAR's) and Pre-NAR's at scheduled intervals. These reviews will serve as approval gates for proceeding to the next phase of development. The reviews will be conducted through Code D by the Independent Program Assessment Office using support from the Center Systems Management Office and external subject matter experts as required. During program or project implementation, the IPAO will maintain surveillance and re-engage the review team if program/project metrics reveal deviations from the Project Plan. IPAO surveillance will be accomplished by planned continuous data exchanges between assigned IPAO representatives and project management; the IPAO will also attend key technical and management reviews. A waiver log will be maintained and current at all times by each Project and approved by appropriate officials.

The Program Management Council (PMC) has drafted a revision to the purpose section of the PMC charter to include "ensuring program and project execution and commitments remain consistent with the NASA vision and associated higher-level requirements." We will work with the Space Architect's office to continually assess the interdependencies of programs and projects on one another. The guidance and support of the PMC will ensure that those dependencies are solid through rigorous and systematic reporting and assessment.

Code D has been reestablished to ensure agency development efforts and mission operations are planned and we will benefit from a more organized corporate approach to our technical work. This is the first major step to improve the efficiency, effectiveness, and reliability of our technical work.

A centralized, collaborative, communicative engineering organization will be managed from Headquarters without stifling initiative in the field; this will produce more reliable work on the balance than independent *laizze-faire* efforts within each Center can, or by tenuously overseen contractors.

The fundamental objection to the current process for making engineering decisions, in which the cognizant engineers all report to the project manager, is that there is little effective oversight of the process either by line management or by independent reviewers. To mitigate this, each Center Engineering Director not only reports to the Center Director but they will functionally report to the NASA Chief Engineer. All engineering at the Center will be under the direction of the Director of Engineering, and will be matrixed to the programs and projects.

As schedule and cost are always constraint considerations, the Program/Project Chief Engineers, Lead Systems Engineers, etc. will make technical decisions without the pressures of schedule and cost.

The Director of Engineering will be briefed on technical issues to stay informed, and to participate in the resolution when necessary. The Director of Engineering will also report technical issues to the Office of the Chief Engineer.

With the establishment of NASA's Engineering and Safety Center, some of the work that Code D had envisioned being done at Headquarters will now be done for Headquarters by NESC. This will improve our ability to maintain awareness of technical problems, bring resources to bear for resolution, and enable informed decisions at Headquarters.

4.10.2 Code Q, Office of Safety and Mission Assurance, Diaz Team Action 9: Independent Technical Engineering Authority

Accountability: The lead for this action is Code Q in collaboration with the Enterprises, the Centers, Code D and other Headquarters organizations as necessary.

SUMMARY APPROACH

- Evaluation of the present organizational arrangement for the management of S&MA effectiveness.
- Propose an approach to implementation of an ITEA within the Office of Space Flight.
- Adapt the ITEA concept to other Enterprises outside of the Office of Space Flight.

Approach: OSMA will evaluate the present organizational arrangement for the management of Safety and Mission Assurance with respect to its effectiveness for the reporting of independent assessments and analysis. This evaluation will consider other reviews currently planned or underway such as the National Academy of Public Administration (NAPA) study of the NASA organization and the study being performed by the Roles, Responsibilities, and Structure team that is charged by the Administrator to clarify the roles of the Headquarters functional offices, the Enterprise Institutional Program Offices (IPOs), and the Center Directors. The outcome of this evaluation could result in a recommendation to the Administrator for changes to the existing Safety and Mission Assurance organizational structure. These recommendations will enhance the ability for independent and unconstrained advice and counsel to the appropriate level of management expected to make risk acceptance decisions.

With respect to the Agency-wide implementation of the Independent Technical Engineering Authority (ITEA), the OSMA is currently proposing approaches to the Office of Space Flight, for implementing an ITEA concept within not only the Space Shuttle program, but also the International Space Station Program, as a part of the on-going response to the Columbia Accident Investigation Board Report and preparation for the Space Shuttle Return to Flight. This work will further define and refine not only the concept of operation of the ITEA but will also specify roles and responsibilities within the Space Shuttle Program including the relationship of the ITEA with SMA and the engineering organization. These same concepts for the ITEA are also being addressed with each of the other Enterprises in the Agency and after the concept is refined and implemented within the human spaceflight programs OSMA, in close coordination with the Enterprise Associate Administrators will adapt the concepts for use in support of other programs and activities across the Agency.

4.11 RISK MANAGEMENT

Twelve "Risk Management" actions were developed in the Diaz Team Report and assigned to Codes D, Q, and G. Six have been consolidated into a single Code D action as shown in Exhibit 4.11-1.

4.11.1 Code D, Office of the Chief Engineer

Code D has consolidated the following five Diaz Team actions into a single "Risk Management" action:

- **Diaz Team Action 3:** Review current policy, criteria, and contractual guidance regarding supply chain, sparing, and obsolescence policy for critical mission support.
- **Diaz Team Action 6:** Develop a standard for program development strategy based on the program focus of R&D versus operational system or infrastructure that focuses on the comprehensive assessment of program management, technical, and operational risks; all of these factors must be incorporated into the development of an integrated program schedule.
- **Diaz Team Action 16:** Review current policies and waivers on safety factors.
- **Diaz Team Action 20:** Review current policy for obsolescence determination, system maintenance, and adherence to manufacturer's warranty.
- **Diaz Team Action 22:** Review current policy, criteria, and contractual guidance regarding supply chain, sparing, and obsolescence policy.
- **Diaz Team Action 29:** Develop a standard and process for anomaly identification, trending, classification, tracking, and resolution management.

Accountability: The implementation lead for this action will be Code D in close coordination with Code Q whose responsibility for Action 19 under "Processes and Rules" has been augmented with responsibility for Action 29. Coordination is also required with Code H with regard to the ongoing Risk Based Acquisition Management (RBAM) initiative.

SUMMARY APPROACH

- Collaborate with Code Q on the coupling of Diaz Team Action 29 with Action 19.
- Review current risk management policies, procedures and practices in use within the Agency.
- Develop an engineering NPR to address risk throughout the program/project lifecycle.
- Perform compliance audits.

Approach: Code D will collaborate with the Office of Safety and Mission Assurance to review current risk management policies, procedures and practices in use today, and will revise as necessary.

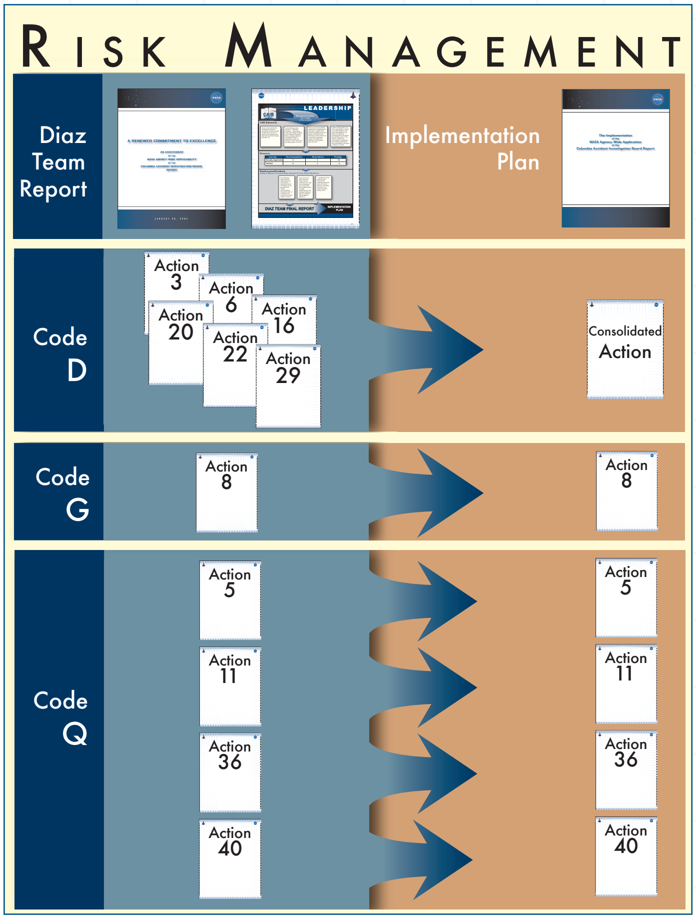


Exhibit 4.11-1. Risk Management Action Mapping from the Diaz Team Report to the Implementation Approach.

An Engineering NPR will be developed, which will be a parallel for the technical community as 7120.5 is to the program/project management community, and will address risk throughout the program/project lifecycle. For operational programs/projects, the NPR will include requirements for sparing, maintenance, obsolescence, and recertification. These requirements will be incorporated into the normal process and will be scrutinized at all reviews.

A policy for identifying, tracking, and dispositioning anomalies will be developed along with resultant procedures. This practice is currently in place, but it is not consistently performed throughout the Agency. Most of the hardware/software processing is performed by contractors at their facilities. NASA will perform audits of the process to ensure that it is constantly applied. This will be assessed prior to integration into the higher level of assembly or a major test.

The approach for Diaz Team Action 19 was revised to additionally address Diaz Team Action 29.

The detailed action plan that is in development by Code D will list all of the necessary activities.

4.11.2 Code G, General Counsel, Diaz Team Action 8. Review the Current Memorandum of Agreement (MOA) with the National Imagery and Mapping Agency (now the National Geospatial-Intelligence Agency (NGA)).

Accountability: Code G is the lead organization in this action in collaboration with the Enterprises.

> **SUMMARY APPROACH**
>
> - Develop an MOA to identify and implement processes to request human and robotic space flight assessments; clarify and establish interagency points of contact; and ensure that the results are provided to those who require the data in a timely and effective manner.
> - Ensure the availability of adequate space for data management and dispositioning.
> - Validate processes through training exercises and rigorous simulations.
> - Provide periodic capability updates.
> - Develop a process to incorporate NASA requirements into future planned systems and architectures.
> - Develop a plan for dissemination of information to the public as necessary.

Approach: NASA will, in collaboration with the Enterprises, develop comprehensive Memoranda of Agreement that will identify and implement processes to request human and robotic space flight assessments as well as clarify and firmly establish interagency points of contact to ensure appropriate assessments are made and that the results are provided to those who require the data in a timely and effective manner.

NASA will likewise identify adequate and timely processes to inform NASA personnel of the scope and availability of assessments, to ensure thorough familiarity with the types and quality of available assessment information. NASA will also ensure the availability of adequate and appropriate spaces for the receipt, transmittal, management, and use of all assessment data, including potential national security information.

The action plan will provide for thorough validation of processes through training exercises and simulations rigorous enough to ensure all appropriate processes for requests, transmittal, management, and appropriate use of all data received are in effect. NASA will implement processes to ensure that program managers and all other appropriate personnel in the space flight process are continually informed and updated on capabilities as they either improve or degrade.

The action plan will ensure adequate processes and points of contact to assure the incorporation of NASA requirements for future planned system and architecture upgrades.

NASA will also proactively plan for the appropriate dissemination of information to the media and the public through established processes coordinated with all other agencies providing assessments.

4.11.3 Code Q, Office of Safety and Mission Assurance

The Diaz Team assigned four actions to Code Q in "Risk Management," but these actions remain independent and not consolidated.

4.11.3.1 Diaz Team Action 5. Review Current Policies Associated with the Uniform Application of Risk Acceptance for Orbital Operations

Accountability: The implementation lead for this action will be Code Q, with collaboration from: Code D for modeling and simulation standards; Code B for budgetary; and Code I for DOD interface.

> **SUMMARY APPROACH**
>
> - Perform more effective assessment of MMOD populations; estimate uncertainties and impact of uncertainties on risk calculations.
> - Identify acceptable risk criteria based on mission class and document in NRP 8710.3.A or other appropriate directive.
> - Develop an Agency-wide policy for MMOD risk management through monitoring, management, and operational contingencies including warning and avoidance.
> - Determine the most effective investment strategy for MMOD risk minimization.
> - Develop a process for ensuring collaboration with SPACETRACK.

Approach: The Office of Safety and Mission Assurance will provide an assessment of the characterization of the following:

- Micrometeoroid and orbital debris (MMOD) populations
- Associated uncertainties in MMOD population estimates, and
- Impact of uncertainty on the models and methods for calculating risk to space vehicles including a better understanding of specific vehicle vulnerabilities and hypervelocity impact responses.

This assessment will define a common baseline and approach for the characterization of the debris field, the calculation of the risk to each system on either a "per mission" or annual basis, and also a characterization of the uncertainty in the models and effect on the risk estimates (in terms of "best" and "worst" case risk estimates).

OSMA will identify acceptable risk criteria on the basis of mission class including human-rated programs, near-earth robotic missions, deep-space robotic missions, expendable launch vehicles, and unique mission or science needs. These requirements will be documented in a policy that will define minimum risk acceptance criteria; it is anticipated that this would result in a revision of NASA Policy Directive 8710.3A, or other policy or program management directive, and any accompanying procedures and standards for MMOD risk acceptance criteria.

An Agency-wide policy will be developed for comprehensive MMOD risk management through monitoring, management, and operational contingencies including Agency-wide policy and capability for MMOD warning and avoidance. This policy will address the overall agency requirements based on all orbital program requirements to determine the most effective course of investment including research and funding of other Agency assets such as the SPACETRACK infrastructure for MMOD characterization. The intent will be to require the risk/benefit analysis based not only on the system cost, but on the cost risk associated with sunk (investment) costs of such systems as the ISS. A process will be developed for ensuring that NASA consistently collaborates with SPACETRACK management and for incorporating their support in decisions that could impact NASA operations.

4.11.3.2 Diaz Team Action 11. Review current policies associated with public risk on launch, overflight, end of life reentry of previously manned or robotic spacecraft, and recovery of any NASA asset as well as the handling and transportation of hazardous materials. Determine if the policies, if implemented, meet the intent of the CAIB recommendation.

Accountability: The lead organization for this action is Code Q with support from the Enterprises, Centers, and other organizations as necessary.

SUMMARY APPROACH

- Develop and implement an Agency Range Safety Risk policy for protecting the public, NASA workforce, and property.
- Perform research on prior risk assessments including interviews as necessary.
- Develop requirements suitable to all operations including risk perspectives across all current and potential programs at NASA.
- Define acceptable risk criteria and ensure consistency with other government, commercial, and industry operations.
- Develop management approval process consistent with level of public risk.
- Develop a process for risk assessment that is consistent with the level of system knowledge and operational experience.
- Coordinate policy with orbital debris risk policy which covers end-of-life reentry.
- Perform audits and periodic reviews for policy compliance.

Approach: On the direction of the Administrator, OSMA will develop and implement an Agency Range Safety Risk Policy for protecting the public, the workforce, and property. The following steps will be taken to accomplish this objective:

- Perform the initial development and coordination on the risk policy. This effort will include NASA Centers and other government agencies involved in NASA range operations; e.g., DoD and FAA.
- Conduct a comprehensive technical review of the CAIB-initiated reentry risk study that was performed by ACTA, Inc.
- Obtain from the lead CAIB Staff Investigator for public risk his perspective on the CAIB investigation and recommendations related to assessing public risk.
- Obtain Agency-wide perspective on application of risk assessment to range operations for all current and future programs (e.g., Shuttle, Expendable Launch Vehicles, Reusable Launch Vehicles, Unmanned Aerial Vehicles, and high altitude balloons).
- Develop requirements that apply to all range flight operations.
- Incorporate performance standards that provide for safety while allowing appropriate flexibility needed to accomplish mission objectives.
- Include acceptable risk criteria and requirements for risk assessment, mitigation, and acceptance/disposition of residual risk to the public, workforce, and property.
- Include criteria and requirements that are consistent with those used throughout the government and commercial range community and consistent with other industries whose activities present a hazard to the public.
- Provide for a risk management process within which the required level of management approval increases as the level of assessed risk to the public and the workforce increases.
- Allow the fidelity of program risk assessments to improve over time as knowledge of a vehicle's operational characteristics increases and associated models used to calculate risk are refined.
- Ensure that the range safety risk policy for over-flight of launch and entry vehicles and recovery of any NASA assets is consistent with the orbital debris risk policy, which covers the end-of-life reentry (i.e., disposal) of previously crewed or robotic spacecraft.

Upon promulgation of the range safety policy and requirements, OSMA will schedule audits of three programs to assess the programs' risk, as well as provide information that can be used to fine-tune the policy/requirements. For the future, OSMA will oversee the implementation of the policy and will include periodic program reviews for ensuring compliance. NASA will continue to interface with national and local range authorities associated with NASA range operations and develop any appropriate memorandum of agreements concerning risk assessment and acceptance in the fulfillment of the established policy.

4.11.3.3 Diaz Team Action 36. Review current policies and standards for risk assessment to include cost, technical, and schedule risk considerations.

Accountability: The implementation lead for this action will be Code Q with collaboration from: Code D for standards; B for budgetary; F for training; J for facility standards; X for security; and the Enterprises for procedural application. Coordination is also required with Code H with regard to the ongoing RBAM initiative.

Summary Approach

- Perform a comprehensive review of the current standards, guidelines, and tools for risk assessment.
- Develop a standard of general applicability across all programs that incorporates best practices from other federal agencies or society standards as appropriate.
- Consider issues of obsolescence, program/project risk, technology development, and life cycle.
- Perform periodic program audits to identify any policy deviations and any required corrective actions.

Approach: OSMA will build on the sound basis already established for the Agency and will further review, refine, establish, and more broadly communicate policies and procedures for risk identification, assessment, and mitigation. These requirements will apply to all programs, operations, and functions. These requirements for risk assessment will also apply to management activities intended to identify reserves to mitigate unplanned risk.

The approach starts with a comprehensive review of the current standards, guidelines, and tools for risk assessment from the standpoint of program planning, including budget and schedule preparation. The implementation will develop a standard that is generally applicable for all programs. As part of the effort to further enhance NASA's capabilities, additional comparisons to applications in other major federal programs such as DOD and NRC, and ASME will be considered as a part of our benchmarking effort.

The approach will ensure consistency with other Diaz Team recommendations associated with risk assessment and management including the consideration of obsolescence, program/project risk, technology development, and life cycle phases. The approach will be consistent with the use of decision support tools and models to support program risk management activities. Periodic program audits will be employed to identify deviations, any required corrective actions to ensure compliance with established program requirements and planning, and to develop contingency reserves for risk management activities. Implementation of this action item will begin with an evaluation of related documents including, but not limited to the presently existing policy and requirements in NPR 7120.5A, NPR 8000.4, and NPR 8705.TBD. At a suitable time, OSMA will then assess the degree of effective application of these standards across the Agency.

4.11.3.4 Diaz Team Action 40. Review Current Policies and Regulations on Industrial Safety Programs.

Accountability: The implementation lead for this action will be Code Q with collaboration from Code F for training, Code O for the workplace, and Code Z for occupational health.

Summary Approach

- Assure that policies and requirements are consistent with federal safety requirements.
- Schedule and conduct at least three process verifications at the Centers within the next year.
- Compile results of the process verifications and develop recommendations/corrective actions as necessary.
- Monitor Center efforts to achieve appropriate certification efforts.
- Coordinate with Code F to ensure that safety culture efforts are consistent with the Organizational and Safety Climate & Culture Change Contract.

Approach: As an integral part of the Agency policy review and requirements identification action assigned in December 2003 by the Associate Deputy Administrator for Institutions and Asset Management, OSMA will assure that policies and requirements are consistent with federal safety requirements. These revalidated requirements will be the baseline for OSMA to continue to perform Process Verifications to evaluate the "health" of the industrial safety program across all Centers and programs. OSMA will schedule and conduct at least three Process Verifications of Center's industrial safety programs within the next 12 months. OSMA will compile the results of the Process Verifications, develop recommendations based upon the findings, and request corrective action from the Center Director through the associated Enterprise Associate Administrator. Results of the Process Verifications will be provided to all NASA Centers to preclude recurrence of like deficiencies and, if necessary, NASA policy will be amended to help assure a safe and healthful work place for all NASA employees.

OSMA will also monitor the results of Center efforts to achieve OSHA Voluntary Protection Program (VPP) Star or other suitable third-party certification status. By teaming with OSHA to achieve Star status or with other organizations to pursue similarly robust safety certifications, NASA will achieve management commitment and employee involvement within the NASA operational safety program.

OSMA will coordinate with Code F the prospect for using the Performance Evaluation Profile (PEP) (developed for OSMA) as a tool for assessment of the "health" of the safety program across the Agency and assure that there is no conflict with the present effort for "safety culture" evaluation being addressed by the Organizational and Safety Climate & Culture Change Contract. Using results from the Process Verifications and, possibly, the PEP, as well as other input including VPP, other third-party reviews and the Agency safety culture effort by the Organizational and Safety Climate & Culture Change Contract, OSMA will continue to update policy and requirements that are more stringent than OSHA's to help assure that all NASA Centers achieve "world class safety excellence."

5.0 Next Steps: Supporting Cultural Transformation

Diaz Team Report, Chapter 10, Page 50:

The proposed actions in the Diaz Team Report are based on culture-related issues identified by NASA leadership and the workforce in the areas of: leadership, learning, communication, processes and rules, technical capabilities, organizational structure, and risk management. The Team believes this systemic approach to cultural change at this critical juncture of the Agency's history will yield a NASA culture that is significantly more responsive and prepared for the promising opportunities of the American space program's future.

The Diaz Team recognized that the most challenging changes facing the Agency today will be those that pertain to culture. They further recognized that there was a broader need for cultural change within NASA that they were not specifically addressing. While the implementation of the 40 Diaz Team actions and the seven goals represent one step towards cultural change, it wasn't intended to be comprehensive. There are numerous efforts underway within the Agency today that address elements of NASA's culture which include One NASA and its focus on breaking down "functional stovepipes" within the Agency and improving communication; the Roles, Responsibilities and Structure Team and its focus on strengthening the management, integration, and clarity of roles throughout the Agency; the continuing dialog resulting from Safety and Mission Success week; and the study that will be conducted by the National Academy of Public Administration to focus on our strategic human capital management and on organizational structure, management, and performance. Other activities are underway as well. NASA realized the need for overall integration of all such efforts in order to maximize their effect on changing the culture of the Agency. The current Organizational and Safety Climate and Culture Effort NASA is underway with the assistance of Behavioral Science Technology, Inc. and serves as an integration point to ensure that all the Agency's ongoing efforts related to culture change are aligned in a manner conducive to a comprehensive organizational and safety climate and culture transformation.

Accountability: The accountability for implementation of this cultural transformation resides with the Associate Deputy Administrator for Institutions and Asset Management working with the Enterprise Committee and other organizations within NASA.

Approach: The Agency's approach to cultural transformation includes:

- Assessing the data gathered from the recently completed Organizational and Safety Climate and Cultural Change Survey
- Integrating all cultural efforts under the leadership of the ADA/I
- Revalidating the Agency's core values
- Aligning the core leadership team at each Center and HQ around the NASA values, the newly developed Guiding Principles for Safety Excellence, the principles of One NASA, and the success factors that are important to implementing those values and principles
- Creating individual Implementation Plans for each member of the core leadership team that will address how each leader will adapt critical leadership behaviors
- Creating a behavioral observation and feedback process for all leadership and supervisory positions
- Implementing organizational behavior-based, team effectiveness training and exercises to improve the communications effectiveness
- Providing training on cognitive bias
- Implementing a competency-based performance management/accountability system
- Augmenting and enhancing the NASA competency model to include leadership competencies in greater detail
- Conducting competency-based job analysis for all leadership positions, to be used in selection decisions
- Evaluating current NASA leadership development programs and activities to determine the extent to which they support the new NASA culture and address longer-term leadership issues
- Enhancing the effectiveness of safety and mission assurance personnel through the alignment of their activities.

Specific action steps will be taken in implementing each of the above. The progress of this approach will be measured in five months. At that time a determination will be made as to which parts of the overall approach will be rolled out further within the Agency.

Appendix A The Diaz Team Action Matrix

1. The CAIB Report listed 29 recommendations, 27 observations, and 137 findings for a total of 193. From the 193 R-O-Fs, the Diaz Team selected 85 that they believe are broadly applicable across all of NASA.

2. The 85 broadly applicable R-O-Fs resulted in 40 specific actions. Each action is comprised of multiple tasks and has a NASA Headquarters code assigned with primary responsibility for preparing an Implementation Plan. The responsible NASA Headquarters code will coordinate with other organizations as necessary to accomplish this. The responsible codes are:

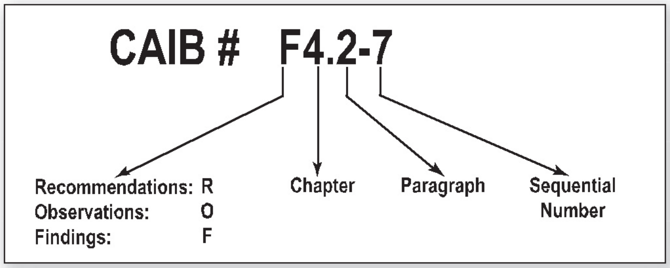
- Code D (Office of the Chief Engineer)
- Code F (Office of Human Resources)
- Code G (Office of the General Counsel)
- Code H (Office of Procurement)
- Code O*(Office of Institutional and Corporate Management)
- Code Q (Office of Safety and Mission Assurance)
- Code X (Office of Security Management and Safeguards)

3. The Diaz Team numbered each of the R-O-Fs with a unique identifier as shown below:

   a. Recommendations: R1 through R29
   b. Observations: O1 through O27
   c. Findings: F1 through F137

4. Each Specific Action is numbered sequentially 1 through 40.

5. The CAIB Report used the schema shown below to identify each R-O-F.



* Code J has been changed to Code O, but the Diaz Team Action Matrix was not changed to maintain its integrity.

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
R1	R3.2-1	Initiate an aggressive program to eliminate all External Tank Thermal Protection System debris-shedding at the source with particular emphasis on the region where the bipod struts attach to the External Tank. [RTF]				
R2	R3.3-1	Develop and implement a comprehensive inspection plan to determine the structural integrity of all Reinforced Carbon-Carbon system components. This inspection plan should take advantage of advanced non-destructive inspection technology. [RTF]				
R3	R3.3-2	Initiate a program designed to increase the Orbiter's ability to sustain minor debris damage by measures such as improved impact-resistant Reinforced Carbon-Carbon and acreage tiles. This program should determine the actual impact resistance of current materials and the effect of likely debris strikes. [RTF]				
R4	R3.3-3	To the extent possible, increase the Orbiter's ability to successfully re-enter the Earth's atmosphere with minor leading edge structural sub-system damage.				
R5	R3.3-4	In order to understand the true material characteristics of Reinforced Carbon-Carbon components, develop a comprehensive database of flown Reinforced Carbon-Carbon material characteristics by destructive testing and evaluation.				
R6	R3.3-5	Improve the maintenance of launch pad structures to minimize the leaching of zinc primer onto Reinforced Carbon-Carbon components.				
R7	R3.4-1	Upgrade the imaging system to be capable of providing a minimum of three useful views of the Space Shuttle from liftoff to at least Solid Rocket Booster separation, along any expected ascent azimuth. The operational status of these	Y	While the CAIB Report focuses on the Space Shuttle Program and a specific area of risk, all programs need to identify the critical means for monitoring their systems and ensure that the data is collected, observed, and	1) Review/develop current policy or guidance that assures critical event data is collected, observed and analyzed. a. Review/develop a standard for program development strategy	Processes & Rules

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
		assets should be included in the Launch Commit Criteria for future launches. Consider using ships or aircraft to provide additional views of the Shuttle during ascent. [RTF]		analyzed. Without the information, there may be no means of identifying potential incipient failures that could lead to mission degradation, failure, or loss.	based on the program focus of R&D versus operational system or infrastructure that focuses on the comprehensive assessment of program management, technical, and operational risks. b. Review/develop a process to determine appropriate means for observing the program at all phases where risks have been identified along with a means of observing, collecting, trending, archiving, and analyzing data. c. Review/develop a process for program reviews that would ensure that any changes, degradation or improvement, in a relied-upon system, cannot be accomplished without the concurrence of programs. Responsibility: Code AE	
R8	R3.4-2	Provide a capability to obtain and downlink high-resolution images of the External Tank after it separates. [RTF]	Y	Following the rationale for R3.4-1, this capability needs to be available for all phases of the program's execution, especially during times of major program events. Otherwise problem resolutions may be based on guesses or theories as opposed to hard data.	2) Develop a standard for comprehensive program risk management and observable data collection for all phases of program development, test, operation, and enhancement to be used for program management, improvement, anomaly/disaster reconstruction. a. Similar to the Cost Analysis Resource Document (CARD), develop a process for a continuously updated and maintained program document that details the plan for management of program data and ongoing anomaly resolution activities and closeout results. b. Develop a process for periodic independent program review and assessment that validates risk	Processes & Rules

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
					areas and comprehensive monitoring/management based on this standard. <u>Responsibility</u>: Code AE	
R9	R3.4-3	Provide a capability to obtain and downlink high-resolution images of the underside of the Orbiter wing leading edge and forward section of both wings' Thermal Protection System. [RTF]				
R10	R3.6-1	The Modular Auxiliary Data System instrumentation and sensor suite on each Orbiter should be maintained and updated to include current sensor and data acquisition technologies.				
R11	R3.6-2	The Modular Auxiliary Data System should be redesigned to include engineering performance and vehicle health information, and have the ability to be reconfigured during flight in order to allow certain data to be recorded, telemetered, or both, as needs change.				
R12	R3.8-1	Obtain sufficient spare Reinforced Carbon-Carbon panel assemblies and associated support components to ensure that decisions related to Reinforced Carbon-Carbon maintenance are made on the basis of component specifications, free of external pressures relating to schedules, costs, or other considerations.	Y	All programs, whether they are aerospace missions or supporting infrastructure, should make decisions on the use of hardware without finding it necessary to compromise on safety or quality in the face of programmatic pressures. Every program risk assessment should include consideration of the adequacy of hardware development quantities and schedule to assure mission success.	3) Review current policy, criteria, and contractual guidance regarding supply chain, sparing, and obsolescence policy. a. Identify whether program is operational and amenable to Life Cycle Cost (LCC) analysis; identify if program provides mission support and supports critical mission operations. b. Identify best practices across other federal agencies and commercial companies for supply chain management for R&D versus operations programs (for which an LCC analysis is applicable). c. Develop standards and criteria for tracking degradation of capabilities (especially for mission critical support items),	Risk Management

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
					managing obsolescence, re-supply, and refurbishment for supply chain definition and management. d. Incorporate any new policies, criteria or guidance into the risk analysis process. e. Develop standards for program recertification based on obsolescence and other decision criteria such as service life extension. <u>Responsibility</u>: Code AE	
R13	R3.8-2	Develop, validate, and maintain physics-based computer models to evaluate Thermal Protection System damage from debris impacts. These tools should provide realistic and timely estimates of any impact damage from possible debris from any source that may ultimately impact the Orbiter. Establish impact damage thresholds that trigger responsive corrective action, such as on-orbit inspection and repair, when indicated.	Y	All programs should produce, maintain, and validate models to assess the state of their systems and components. These models should be continually updated and validated against experimental and operational data to determine appropriate courses of action and repair. The value of the models should be assessed with respect to their ability to support decision making in a timely way so as not to lead the decision maker to a conflict between costly action versus effective action in the interest of safety or mission success.	4) Develop a standard for the development, documentation, and operation of models and simulations. a. Identify best practices to ensure that knowledge of operations is captured in the user interfaces (e.g. users are not able to enter parameters that are out of bounds). b. Develop process for tool verification and validation, certification, reverification, revalidation, and recertification based on operational data and trending. c. Develop standard for documentation, configuration management, and quality assurance. d. Identify any training or certification requirements to ensure proper operational capabilities. e. Provide a plan for tool management, maintenance, and obsolescence consistent with modeling/simulation environments and the aging or	Technical Capabilities

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
					changing of the modeled platform or system. f. Develop a process for user feedback when results appear unrealistic or defy explanation. Responsibility: Code AE	
R14	R4.2-1	Test and qualify the flight hardware bolt catchers. [RTF]				
R15	R4.2-2	As part of the Shuttle Service Life Extension Program and potential 40-year service life, develop a state-of-the-art means to inspect all Orbiter wiring, including that which is inaccessible.				
R16	R4.2-3	Require that at least two employees attend all final closeouts and intertank area hand-spraying procedures. [RTF]				
R17	R4.2-4	Require the Space Shuttle to be operated with the same degree of safety for micrometeoroid and orbital debris as the degree of safety calculated for the International Space Station. Change the micrometeoroid and orbital debris safety criteria from guidelines to requirements.	Y	All programs should adopt the same standards for risk acceptance and adopt common methodologies for risk assessment. Programs should look for innovative solutions to risk mitigation including use and support of other agency (e.g., DoD) resources.	5) Review current policies associated with the uniform application of risk acceptance for orbital operations. a. Identify institutional standards for requirements for debris avoidance and protection. b. Review liaison responsibility with the Air Force for debris tracking and NASA funding support (as required) with Code Q. Responsibility: Code Q	Risk Management
R18	R4.2-5	Kennedy Space Center Quality Assurance and United Space Alliance must return to the straightforward, industry-standard definition of "Foreign Object Debris" and eliminate any alternate or statistically deceptive definitions like "processing debris." [RTF]				
R19	R6.2-1	Adopt and maintain a Shuttle flight schedule that is consistent with available resources. Although schedule deadlines are an important management tool, those	Y	It has been noted that schedules are sometimes established without an underlying rationale and assessment of risk. As a result, programs across	6) Develop a standard for program development strategy based on the program focus of R&D versus operational system or	Risk Management

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
		deadlines must be regularly evaluated to ensure that any additional risk incurred to meet the schedule is recognized, understood, and acceptable. [RTF]		NASA may not be using schedules as management tools but as concrete dates for performance. NASA needs to continually reevaluate program risk as to whether it is acceptable given NASA policy and standards. This is applicable across all NASA programs whether they be R&D, mission related, or infrastructure.	infrastructure that focuses on the comprehensive assessment of program management, technical, and operational risks; all of these factors must be incorporated into the development of an integrated program schedule. a. Expand upon independent program reviews (Independent Assessments, Independent and Implementation Reviews) that require re-review when any interim major milestone slips to determine the impact on mission completion schedule and cost risk. Responsibility: Code AE	
R20	R6.3-1	Implement an expanded training program in which the Mission Management Team faces potential crew and vehicle safety contingencies beyond launch and ascent. These contingencies should involve potential loss of Shuttle or crew, contain numerous uncertainties and unknowns, and require the Mission Management Team to assemble and interact with support organizations across NASA/Contractor lines and in various locations. [RTF]	Y	All programs should have robust training programs that allow personnel to practice both likely and unlikely failure scenarios to prepare them for contingency management. Simulations should be a routine part of training. This will reduce the potential response shock and enable more effective problem resolution and personnel innovation at multiple organizational levels.	7) Review current policies associated with developing emergency procedures and operational contingencies and associated training and certification. a. After review of policies, conduct an audit of no less than three programs to determine compliance. The training curricula should be for systems, and programs that have requirements for operational support. These systems would be on orbit, flight, underwater, human testing, and any other system or program that requires any type of emergency procedures. b. If required, rewrite the policies to comply with the CAIB recommendation as a minimum. The rewritten policies should go beyond the CAIB recommendation if the minimum	Learning

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
					is not sufficient to affect the changes needed. c. Upon Code AE review of the policies associated with emergency procedures and operational contingencies, and changes made as necessary in a revision to NASA Policy Directive (NPD) 3410, appropriately communicate to Center Directors and Center training officers for compliance. Responsibility: Code AE	
R21	R6.3-2	Modify the Memorandum of Agreement with the National Imagery and Mapping Agency to make the imaging of each Shuttle flight while on orbit a standard requirement. [RTF]	Y	The need to use national assets to assess spacecraft health applies to many programs.	8) Review the current Memorandum of Agreement (MOA) with the National Imagery and Mapping Agency, which is now called the National Geospatial-Intelligence Agency (NGA). a. Expand the MOA to include programs other than Shuttle. b. Ensure that the proper security clearances are maintained for access to classified data. See F6.3-20 Responsibility: Code G	Risk Management
R22	R6.4-1	For missions to the International Space Station, develop a practicable capability to inspect and effect emergency repairs to the widest possible range of damage to the Thermal Protection System, including both tile and Reinforced Carbon-Carbon, taking advantage of the additional capabilities available when near to or docked at the International Space Station. For non-Station missions, develop a comprehensive autonomous (independent of Station) inspection and repair capability to cover the widest possible				

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
		range of damage scenarios. Accomplish an on-orbit Thermal Protection System inspection, using appropriate assets and capabilities, early in all missions. The ultimate objective should be a fully autonomous capability for all missions to address the possibility that an International Space Station mission fails to achieve the correct orbit, fails to dock successfully, or is damaged during or after undocking. [RTF]				
R23	R7.5-1	Establish an independent Technical Engineering Authority that is responsible for technical requirements and all waivers to them, and will build a disciplined, systematic approach to identifying, analyzing, and controlling hazards throughout the life cycle of the Shuttle System. The independent technical authority does the following as a minimum: • Develop and maintain technical standards for all Space Shuttle Program projects and elements • Be the sole waiver-granting authority for all technical standards • Conduct trend and risk analysis at the sub-system, system, and enterprise levels • Own the failure mode, effects analysis and hazard reporting systems • Conduct integrated hazard analysis • Decide what is and is not an anomalous event • Independently verify launch readiness • Approve the provisions of the	Y	All programs should have the benefit of an independent engineering authority to ensure that technical standards are being met. No programs should have the ability to waive technical standards or compromise a standard without the review and approval of an appropriate engineering authority. All projects and programs should conduct risk analysis consistent with Agency policy regarding risk management. All Centers should have the capability in either their engineering or Safety and Mission Assurance (SMA) organizations to perform and or review failure modes and effects analysis, and hazard analysis. For manned and unmanned flights and launches, Centers should establish flight, mission, or launch readiness certification processes that include verification by the independent engineering and SMA organizations. Independence is defined as both organizational (outside the operations, project or program structure) as well as financial (funding allocation decisions made or approved) at the first organizational level that owns both the operation, project or program and the center engineering and SMA	9) Develop plans for implementing an Independent Technical Engineering Authority (ITEA) of the scope envisioned by the CAIB. a. Develop organizational approaches that assure independence of Safety, Reliability, and Quality Assurance (SR&QA) activities and organizations. b. Implement the ITEA organization. <u>Responsibility</u>: Code Q	Organizational Structure

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		recertification program called for in Recommendation R9.1-1 The Technical Engineering Authority should be funded directly from NASA Headquarters, and should have no connection to or responsibility for schedule or program cost.		organizations.		
R24	R7.5-2	NASA Headquarters Office of Safety and Mission Assurance should have direct line authority over the entire Space Shuttle Program safety organization and should be independently resourced.	Y	All programs having an impact on operational safety should have the benefit of an independent safety organization for assurance. This approach supplements the in-line safety, quality, reliability and mission assurance efforts by providing independence from any perceived conflicts due to program budgets and schedules. This is important across all programs, including infrastructure programs that could have a direct or indirect impact on space vehicle mission success and safety. The establishment of the NASA Engineering and Safety Center (NESC) as an enhancement to the agency's independent safety capability is noted and endorsed. As in R7.5-1, independence is defined as both organizational and financial with respect to the activity being served by the assurance team.	Same as R7.5-1	Organizational Structure
R25	R7.5-3	Reorganize the Space Shuttle Integration Office to make it capable of integrating all elements of the Space Shuttle Program, including the Orbiter.				
R26	R9.1-1	Prepare a detailed plan for defining, establishing, transitioning, and implementing an Independent Technical Engineering Authority, independent safety program, and a reorganized Space Shuttle Integration Office as described in R7.5-1, R7.5-2, and R7.5-3. In addition, NASA should submit annual reports to Congress, as part of the budget review process, on its implementation activities.	Y	NASA should address the formation of these organizations subject to R7.5-1. The process should allow for an orderly transition to avoid any unintended consequence in the process.	Same as R7.5-1	Organizational Structure

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		[RTF]				
R27	R9.2-1	Prior to operating the Shuttle beyond 2010, develop and conduct a vehicle recertification at the material, component, subsystem, and system levels. Recertification requirements should be included in the Service Life Extension Program.				
R28	R10.3-1	Develop an interim program of closeout photographs for all critical sub-systems that differ from engineering drawings. Digitize the closeout photograph system so that images are immediately available for on-orbit troubleshooting. [RTF]	Y	All programs should maintain a log and photographic record of all critical sub system modifications and their engineering drawings to ensure real-time access to the latest configurations for configuration management and problem resolution. This will help reduce the time and cost to reconstruct the current system configuration whether it be on orbit, in a ground station, or in a laboratory.	10) Review current policies and capabilities associated with configuration control, closeout photographs, and engineering drawings. Determine if the policies if implemented, meet the intent of the CAIB recommendation. a. After review of policies, conduct an audit of no less than three programs to determine compliance. If the programs are compliant, determine if the methods used are adequate. b. If required, rewrite the policies to comply with the CAIB recommendation as a minimum. The rewritten policies should go beyond the CAIB recommendation if the minimum is not sufficient to affect the changes needed. Responsibility: Code AE	Technical Capabilities
R29	R10.3-2	Provide adequate resources for a long-term program to upgrade the Shuttle engineering drawing system including: • Reviewing drawings for accuracy • Converting all drawings to a computer-aided drafting system • Incorporating engineering changes	Y	Accurate, comprehensive, up-to-date engineering drawings should be maintained for all programs. All programs should have adequate resources to maintain a drawing system that is Computer-Aided Design (CAD) based and can incorporate engineering changes.	Same as R10.3-1	Technical Capabilities

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Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
O1	O10.1-1	NASA should develop and implement a public risk acceptability policy for launch and re-entry of space vehicles and unmanned aircraft.	Y	The FAA and DoD both have policies that require public risk analyses for programs under their purview. NASA does and should continue to do this as well if there is any issue of public risk through launch or reentry of a vehicle, over-flight of an aerodynamic test vehicle, or handling/transportation of material that could lead to public risk.	11) Review current policies associated with public risk on launch, overflight, end of life reenentry of previously manned or robotic spacecraft, and recovery of any NASA asset as well as the handling and transportation of hazardous materials. Determine if the policies, if implemented, meet the intent of the CAIB recommendation. a. NASA should consider Federal and commercial best practices with respect to public risk management to determine if any policies and practices are applicable and transferable to NASA. b. After Review of Policies, conduct an audit of no less than three programs to determine compliance. If the programs are compliant, determine if the methods used are adequate. c. If required, rewrite the policies to comply with the CAIB recommendation as a minimum. The rewritten policies should go beyond the CAIB recommendation if the minimum is not sufficient to affect the changes needed. <u>Responsibility</u>: Code Q	Risk Management
O2	O10.1-2	NASA should develop and implement a plan to mitigate the risk that Shuttle flights pose to the general public.				
O3	O10.1-3	NASA should study the debris recovered from *Columbia* to facilitate realistic estimates of the risk to the public during Orbiter re-entry.				

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Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
O4	O10.2-1	Future crewed-vehicle requirements should incorporate the knowledge gained from the *Challenger* and *Columbia* accidents in assessing the feasibility of vehicles that could ensure crew survival even if the vehicle is destroyed.				
O5	O10.4-1	Perform an independently led, bottom-up review of the Kennedy Space Center Quality Planning Requirements Document to address the entire quality assurance program and its administration. This review should include development of a responsive system to add or delete government mandatory inspections.				
O6	O10.4-2	Kennedy Space Center's Quality Assurance programs should be consolidated under one Mission Assurance office, which reports to the Center Director.				
O7	O10.4-3	Kennedy Space Center quality assurance management must work with NASA and perhaps the Department of Defense to develop training programs for its personnel.				
O8	O10.4-4	Kennedy Space Center should examine which areas of International Organization for Standardization 9000/9001 truly apply to a 20-year-old research and development system like the Space Shuttle.	Y	NASA programs should assess whether programs are operational or inherently R&D and then determine the applicability of standardization and certification processes.	12) Review current initiatives for International Standards Organization (ISO) and Software Engineering Institute Capabilities Maturity Model (SEI CMM) across the agency to determine if they are meeting the objectives of NASA and are cost and operationally effective. a. Develop a policy that is NASA wide on the use of initiatives like ISO and SEI CMM. <u>Responsibility</u>: Code AE	Processes & Rules
O9	O10.5-1	Quality and Engineering review of work documents for STS-114 should be accomplished using statistical sampling to ensure that a representative sample is	Y	Program audits and random checks of documentation, subject to the rigors of statistical significance, are advised including feedback to those appropriate.	13) Review current policies program and technical audits across NASA. Determine if the policies if implemented meet the	Processes & Rules

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		evaluated and adequate feedback is communicated to resolve documentation problems.			intent of the CAIB recommendation. a. Conduct an audit of no less than three programs using statistical sampling techniques. b. Compile the results: develop a recommendation on conducting routine and random audits of all NASA programs, to include adequate feedback to those responsible for resolving problems. c. Develop or rewrite a policy for conducting audits. <u>Responsibility</u>: Code AE	
O10	O10.5-2	NASA should implement United Space Alliance's suggestions for process improvement, which recommend including a statistical sampling of all future paperwork to identify recurring problems and implement corrective actions.				
O11	O10.5-3	NASA needs an oversight process to statistically sample the work performed and documented by United Space Alliance technicians to ensure process control, compliance, and consistency.	Y	All NASA oversight processes should include statistical sampling of performed work and statistical data analysis to assure integrity of processes and hardware.	Same as O10.5-1	Processes & Rules
O12	O10.6-1	The Space Shuttle Program Office must make every effort to achieve greater stability, consistency, and predictability in Orbiter Major Modification planning, scheduling, and work standards (particularly in the number of modi-fications). Endless changes create unnecessary turmoil and can adversely impact quality and safety.				
O13	O10.6-2	NASA and United Space Alliance managers must understand workforce and infrastructure requirements, match them against capabilities, and take actions to avoid exceeding thresholds.	Y	All NASA managers must maintain a constant awareness of workforce and facility requirements and match them against capabilities and take action when exceeding thresholds.	14) Identify policies associated with workforce and infrastructure/ facilities management and obsolescence. a. Conduct an agency-wide audit of infrastructure backlog	Leadership

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					maintenance and repair; identify which programs they support, and whether they have mission critical functions. b. Conduct an audit of no less than three programs using available cost and staffing levels to determine if the programs are balancing the available workforce and infrastructure against capabilities and schedules. Determine if the programs are using any type of scheduling, or workforce allocation tools. c. Determine if existing tools such as the workforce planning and analysis website, the Agency competency management system, and the Agency master planning/infrastructure tools can be used to improve workforce and infrastructure planning. d. Compile the results of above; develop a recommendation(s). e. If required, develop policy (linkage) between workforce planning and infrastructure tools/policies and the set of minimum thresholds that shall be met. Responsibility: Code J	
O14	O10.6-3	NASA should continue to work with the U.S. Air Force, particularly in areas of program management that deal with aging systems, service life extension, planning and scheduling, workforce management, training, and quality assurance.	Y	Other organizations with similar and dissimilar research and development and large systems operational experience have best practices and lessons learned that could be of value to NASA program management.	15) Form a workgroup to benchmark best practices from Federal agencies (e.g., DoD, FAA, DOE), and commercial industries. a. Compile the results; establish a permanent working group to address common issues, and a senior leadership group to oversee its functioning.	Leadership

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					b. Develop or rewrite policies that implement these best practices. Responsibility: Code AE	
O15	O10.6-4	The Space Shuttle Program Office must determine how it will effectively meet the challenges of inspecting and maintaining an aging Orbiter fleet before lengthening Orbiter Major Maintenance intervals.				
O16	O10.7-1	Additional and recurring evaluation of corrosion damage should include non-destructive analysis of the potential impacts on structural integrity.				
O17	O10.7-2	Long-term corrosion detection should be a funding priority.				
O18	O10.7-3	Develop non-destructive evaluation inspections to find hidden corrosion.				
O19	O10.7-4	Inspection requirements for corrosion due to environmental exposure should first establish corrosion rates for Orbiter-specific environments, materials, and structural configurations. Consider applying Air Force corrosion prevention programs to the Orbiter.				
O20	O10.8-1	Teflon (material) and Molybdenum Disulfide (lubricant) should not be used in the carrier panel bolt assembly.				
O21	O10.8-2	Galvanic coupling between aluminum and steel alloys must be mitigated.				
O22	O10.8-3	The use of Room Temperature Vulcanizing 560 and Koropon should be reviewed.				
O23	O10.8-4	Assuring the continued presence of compressive stresses in A-286 bolts should be part of their acceptance and qualification procedures.				
O24	O10.9-1	NASA should consider a redesign of the system, such as adding a cross-strapping cable, or conduct advanced testing for intermittent failure.				
O25	O10.10-1	NASA should reinstate a safety factor of 1.4 for the Attachment Rings—which	Y	Design and safety factors have been developed by many engineering and	16) Review current policies and waivers on safety factors.	Risk Management

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		invalidates the use of ring serial numbers 16 and 15 in their present state—and replace all deficient material in the Attachment Rings.		manufacturing organizations with a broad base of underlying test and supporting data.	a. Conduct an audit of no less than three programs. Determine if the programs are using a 1.4 safety factor, and what waivers have been granted. b. Compile the results and develop a recommendation. c. If required, develop or rewrite a policy for minimum safety factors, and associated waivers. Responsibility: Code AE	
O26	O10.11-1	Assess NASA and contractor equipment to determine if an upgrade will provide the reliability and accuracy needed to maintain the Shuttle through 2020. Plan an aggressive certification program for replaced items so that new equipment can be put into operation as soon as possible.				
O27	O10.12-1	NASA should implement an agency-wide strategy for leadership and management training that provides a more consistent and integrated approach to career development. This strategy should identify the management and leadership skills, abilities, and experiences required for each level of advancement. NASA should continue to expand its leadership development partnerships with the Department of Defense and other external organizations.	Y	Succession planning, leadership training, and personnel enrichment are standard business practices in many organizations including NASA. Review and continuous improvement through benchmarking with other organizations is advised. Opportunities to expand NASA leadership perspectives by participation in external leadership programs should be encouraged throughout the agency.	17) Review current training strategy/policies on management, leadership, and exchange programs used by government and commercial industry (including NASA contractors) for best practices. a. Identify programs, both federal and commercial, for professional enrichment. b. Review/develop standards for advancement in grade based on leadership skills, technical abilities, and operational experience. c. Develop a recommendation for new or improved training programs that address leadership. d. Develop or rewrite the strategy/policy for leadership and management training. Responsibility: Code F	Leadership

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F1	F3.2-1	NASA does not fully understand the mechanisms that cause foam loss on almost all flights from larger areas of foam coverage and from areas that are sculpted by hand.				
F2	F3.2-2	There are no qualified non-destructive evaluation techniques for the as-installed foam to determine the characteristics of the foam before flight.	Y	Programs need to have sufficient testing methodologies to determine that design requirements are met and that product performance is verified prior to NASA acceptance.	18) Review current policy, criteria, and contractual guidance regarding government acceptance. a. Identify best practices across other federal agencies and commercial companies. b. Develop standards for acceptance testing and performance verification. c. Develop and specify suitable inspection techniques for all critical manufacturing processes. <u>Responsibility</u>: Code H	Technical Capabilities
F3	F3.2-3	Foam loss from an External Tank is unrelated to the tank's age and to its total pre-launch exposure to the elements. Therefore, the foam loss on STS-107 is unrelated to either the age or exposure of External Tank 93 before launch.				
F4	F3.2-4	The Board found no indications of negligence in the application of the External Tank Thermal Protection System.				
F5	F3.2-5	The Board found instances of left bipod ramp shedding on launch that NASA was not aware of, bringing the total known left bipod ramp shedding events to 7 out of 72 missions for which imagery of the launch or External Tank separation is available.	Y	Adequate development of root cause determination requires that there be a detailed understanding of whether a failure is an anomaly or systemic.	19) Review procedures for anomaly identification and characterization. a. Develop a protocol to assess the review of past performance to determine the incidence of identical or related anomalies. b. Develop an escalation procedure based on mission criticality. c. Develop closeout process for root cause determination and anomaly mitigation.	Processes & Rules

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					Responsibility: Code Q	
F6	F3.2-6	Subsurface defects were found during the dissection of three bipod foam ramps, suggesting that similar defects were likely present in the left bipod ramp of External Tank 93 used on STS-107.				
F7	F3.2-7	Foam loss occurred on more than 80 percent of the 79 missions for which imagery was available to confirm or rule out foam loss.	Y	Trend analysis needs to be correlated with program requirements for determination of anomalous or systematic problems.	See F3.2-5.	Processes & Rules
F8	F3.2-8	Thirty percent of all missions lacked sufficient imagery to determine if foam had been lost.	Y	Anomalies cannot be addressed if they are not observed. This spans all NASA programs.	See F3.2-5 and R3.4-1.	Processes & Rules
F9	F3.2-9	Analysis of numerous separate variables indicated that none could be identified as the sole initiating factor of bipod foam loss. The Board therefore concludes that a combination of several factors resulted in bipod foam loss.				
F10	F3.3-1	The original design specifications required the RCC components to have essentially no impact resistance.				
F11	F3.3-2	Current inspection techniques are not adequate to assess structural integrity of the RCC components.	Y	Acceptance programs must be well defined and robust.	See F3.2-2	Technical Capabilities
F12	F3.3-3	After manufacturer's acceptance non-destructive evaluation, only periodic visual and touch tests are conducted.	Y	NASA needs to ensure appropriate In-Service Inspection activities are taking place for high-risk areas of repetitive missions.	20) Review current policy for obsolescence determination, system maintenance, and adherence to manufacturer's warranty. a. Identify life-cycle management and inspection practices at other select federal agencies and commercial enterprises. b. Develop standards for nondestructive evaluations of systems and maintenance standards to ensure that performance is not degraded below acceptance levels. c. Develop standards defining	Risk Management

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					robust supply chains to ensure that component availability does not compromise maintenance standards. Responsibility: Code AE	
F13	F3.3-4	RCC components are weakened by mass loss caused by oxidation within the substrate, which accumulates with age. The extent of oxidation is not directly measurable, and the resulting mission life reduction is developed analytically.				
F14	F3.3-5	To date, only two flown RCC panels, having achieved 15 and 19 missions, have been destructively tested to determine actual loss of strength due to oxidation.				
F15	F3.3-6	Contamination from zinc leaching from a primer under the paint topcoat on the launch pad structure increases the opportunities for localized oxidation.				
F16	F3.4-1	Photographic evidence during ascent indicates the projectile that struck the Orbiter was the left bipod ramp foam.				
F17	F3.4-2	The same photographic evidence, confirmed by independent analysis, indicates the projectile struck the underside of the leading edge of the left wing in the vicinity of RCC panels 6 through 9 or the tiles directly behind, with a velocity of approximately 775 feet per second.				
F18	F3.4-3	There is a requirement to obtain and downlink on-board engineering quality imaging from the Shuttle during launch and ascent.	Y	Anomalies can occur during all phases of a mission or operation but cannot be adequately resolved without an ability to observe the performance and communicate the information.	21) Identify methods used by other test organizations to perform remote system testing and anomaly resolution. a. Develop a practice and standard for the determination of baseline observables and telemetry for anomaly sampling, resolution, and detection. b. Perform a comparison of data requirements against available	Technical Capabilities

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					sensor and communications capabilities. c. Identify shortfalls and mitigation requirements in communications architecture to mitigate shortfalls, if possible. d. Develop communications protocols and escalation procedures for anomaly resolution. e. Develop notification procedures for up/down escalation chain and horizontal communications integration. <u>Responsibility</u>: Code AE	
F19	F3.4-4	The current long-range camera assets on the Kennedy Space Center and Eastern Range do not provide best possible engineering data during Space Shuttle ascents.	Y	Observation capabilities for anomaly detection need to have the appropriate resolution and data rates for information gathering and transfer.	See F3.4-3	Technical Capabilities
F20	F3.4-5	Evaluation of STS-107 debris impact was hampered by lack of high resolution, high speed cameras (temporal and spatial imagery data).	Y	Observation of anomalies whether it be on the Space Shuttle, a deep space probe, a ground system, etc… cannot be accomplished without a calculation of the requirements for resolution and sampling	See F3.4-3	Technical Capabilities
F21	F3.4-6	Despite the lack of high quality visual evidence, the information available about the foam impact during the mission was adequate to determine its effect on both the thermal tiles and RCC.				
F22	F3.5-1	The object seen on orbit with *Columbia* on Flight Day 2 through 4 matches the radar cross-section and area-to-mass measurements of an RCC panel fragment.				
F23	F3.5-2	Though the Board could not positively identify the Flight Day 2 object, the U.S. Air Force exclusionary test and analysis processes reduced the potential Flight Day 2 candidates to an RCC panel				

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		fragment.				
F24	F3.6-1	The de-orbit burn and re-entry flight path were normal until just before Loss of Signal.				
F25	F3.6-2	*Columbia* re-entered the atmosphere with a pre-existing breach in the left wing.				
F26	F3.6-3	Data from the Modular Auxiliary Data System recorder indicates the location of the breach was in the RCC panels on the left wing leading edge.				
F27	F3.6-4	Abnormal heating events preceded abnormal aerodynamic events by several minutes.				
F28	F3.6-5	By the time data indicating problems was telemetered to Mission Control Center, the Orbiter had already suffered damage from which it could not recover.				
F29	F3.7-1	Multiple indications from the debris analysis establish the point of heat intrusion as RCC panel 8-left.				
F30	F3.7-2	The recovery of debris from the ground and its reconstruction was critical to understanding the accident scenario.				
F31	F3.8-1	The impact test program demonstrated that foam can cause a wide range of impact damage, from cracks to a 16- by 17-inch hole.				
F32	F3.8-2	The wing leading edge Reinforced Carbon-Carbon composite material and associated support hardware are remarkably tough and have impact capabilities that far exceed the minimal impact resistance specified in their original design requirements. Nevertheless, these tests demonstrate that this inherent toughness can be exceeded by impacts representative of those that occurred during *Columbia*'s ascent.				
F33	F3.8-3	The response of the wing leading edge to impacts is complex and can vary greatly, depending on the location of the impact, projectile mass, orientation, composition,				

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		and the material properties of the panel assembly, making analytic predictions of damage to RCC assemblies a challenge.[17]				
F34	F3.8-4	Testing indicates the RCC panels and T-seals have much higher impact resistance than the design specifications call for.				
F35	F3.8-5	NASA has an inadequate number of spare Reinforced Carbon-Carbon panel assemblies.	Y	Programs should develop robust supply chains based on detailed analysis of logistics requirements and failure analyses.	22) Review current policy, criteria, and contractual guidance regarding supply chain, sparing, and obsolescence policy. a. Identify whether program is operational and amenable to LCC analysis. b. Identify best practices across other federal agencies and commercial companies for supply chain management for R&D versus operations programs (for which an LCC analysis is applicable). c. Develop standards and criteria for managing obsolescence, re-supply, and refurbishment for supply chain definition and management. <u>Responsibility</u>: Code AE	Risk Management
F36	F3.8-6	NASA's current tools, including the CRATER model, are inadequate to evaluate Orbiter Thermal Protection System damage from debris impacts during pre-launch, on-orbit, and post-launch activity.	Y	Same as R3.8-2	See R3.8-2	Technical Capabilities
F37	F3.8-7	The bipod ramp foam debris critically damaged the leading edge of *Columbia*'s left wing.				
F38	F4.2-1	The certification of the bolt catchers flown on STS-107 was accomplished by extrapolating analysis done on similar but not identical bolt catchers in original testing. No testing of flight hardware was performed.	Y	Historically there have been instances of inappropriate application of similarity as the criterion for hardware verification. The Agency should strengthen its instruction in the use of similarity as a verification method.	23) Develop a standard for the modeling and testing (both destructive and nondestructive) of system components and assemblies. a. Identify best practices to ensure	Technical Capabilities

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					that knowledge of operations and trend data is captured and incorporated into test procedures. b. Develop process for component test verification, validation, certification, reverification, revalidation, and recertification based on operational data and trending against component and assembly design specifications. c. Develop escalation process for communicating results of critical mission importance. d. Develop process for incorporation of test data into supply chain management process. Responsibility: Code AE	
F39	F4.2-2	Board-directed testing of a small sample size demonstrated that the "as-flown" bolt catchers do not have the required 1.4 margin of safety.	Y	Periodic testing of program subassemblies and components should occur to determine whether or not design specifications have been compromised; this data is valid in supporting supply chain analyses.	See F4.2-1	Technical Capabilities
F40	F4.2-3	Quality assurance processes for bolt catchers (a Criticality 1 subsystem) were not adequate to assure contract compliance or product adequacy.				
F41	F4.2-4	An unknown metal object was seen separating from the stack during Solid Rocket Booster separation during six Space Shuttle missions. These objects were not identified, but were characterized as of little to no concern.	Y	Unknown anomalies should be considered a problem unless proven otherwise.	24) Identify clear chains of command in a program including responsibility, accountability, and authority for issue communications. a. Develop escalation process for communicating information of critical mission importance. b. Develop communications process up/down escalation path, which also considers horizontal communications integration and informal channels of input.	Communication

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					c. Develop independent conflict resolution process for anomaly mediation and resolution, as required. Responsibility: Code AE	
F42	F4.2-5	Based on the extensive wiring inspections, maintenance, and modifications prior to STS-107, analysis of sensor/wiring failure signatures, and the alignment of the signatures with thermal intrusion into the wing, the Board found no evidence that Kapton wiring problems caused or contributed to this accident.				
F43	F4.2-6	Crushed foam does not appear to have contributed to the loss of the bipod foam ramp off the External Tank during the ascent of STS-107.				
F44	F4.2-7	The hypergolic spill was not a factor in this accident.				
F45	F4.2-8	Space weather was not a factor in this accident.				
F46	F4.2-9	A "rough wing" was not a factor in this accident.				
F47	F4.2-10	The Board concludes that training and on-orbit considerations were not factors in this accident.				
F48	F4.2-11	The payloads *Columbia* carried were not a factor in this accident.				
F49	F4.2-12	The Board found no evidence that willful damage was a factor in this accident.				
F50	F4.2-13	Two close-out processes at the Michoud Assembly Facility are currently able to be performed by a single person.				
F51	F4.2-14	Photographs of every close out activity are not routinely taken.	Y	Best practices from commercial aviation and nuclear power plants are applicable to NASA operations to provide complete documentation if necessary.	25) Identify programs of similar nature with applicable practices for such activities as closeout photographs, program documentation and configuration management to NASA operational and R&D initiatives.	Technical Capabilities

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					a. Develop program case studies of best practices for analysis of problems, solutions, and results from applicable programs. b. Develop standards based on researched best practices for NASA operational and R&D programs. c. Develop publications and continued training to ensure the dissemination of information to NASA and contractor personnel. d. Update and expand as necessary. Responsibility: Code AE	
F52	F4.2-15	There is little evidence that *Columbia* encountered either micrometeoroids or orbital debris on this flight.				
F53	F4.2-16	The Board found markedly different criteria for margins of micrometeoroid and orbital debris safety between the International Space Station and the Shuttle.	Y	Risk determination needs to be uniformly applied across NASA. Programs should have standards for risk acceptance.	See R4.2-4	Risk Management
F54	F4.2-17	Based on a thorough investigation of maintenance records and interviews with maintenance personnel, the Board found no errors during *Columbia*'s most recent Orbiter Major Modification that contributed to the accident.				
F55	F4.2-18	Since 2001, Kennedy Space Center has used a non-standard approach to define foreign object debris. The industry standard term "Foreign Object Damage" has been divided into two categories, one of which is much more permissive.				
F56	F6.1-1	NASA has not followed its own rules and requirements on foam-shedding. Although the agency continuously worked on the foam-shedding problem, the debris impact requirements have not been met on any mission.	Y	Independent audits need to be conducted to identify any deviations from adherence to specifications.	26) Review a minimum of three programs to determine if they are "Following the Rules." a. Conduct an awareness campaign on the need to "follow the rules" for requirements imposed by	Processes & Rules

* Broadly Applicable

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					programs. b. Rewrite policy or practice if required. Responsibility: Code AE	
F57	F6.1-2	Foam-shedding, which had initially raised serious safety concerns, evolved into "in-family" or "no safety-of-flight" events or were deemed an "accepted risk."	Y	An independent organization should identify deviations from program requirements. Unless a requirement is determined as an over-specification and formally waived, any deviation from a design requirement should not be relegated to a lower status. Program Managers should be careful to avoid "normalization of deviance."	27) Develop a standard and process for independent review of all program requirements and operational constraints for consistency and identify all program waivers. a. Conduct an analysis of the history of program anomalies and resolution actions and identify all changes in status consistent with the normalization of deviance. b. Develop course of action to reconcile any deficiencies and refocus on root cause analysis, and anomaly resolution as it relates directly to program requirements. c. Develop a plan for periodic, independent program reviews. Responsibility: Code AE	Organizational Structure
F58	F6.1-3	Five of the seven bipod ramp events occurred on missions flown by *Columbia*, a seemingly high number. This observation is likely due to Columbia having been equipped with umbilical cameras earlier than other Orbiters.				
F59	F6.1-4	There is lack of effective processes for feedback or integration among project elements in the resolution of In-Flight Anomalies.	Y	NASA has many large and complex programs that likely have similar communications and organizational problems. Feedback mechanisms and processes should be established for all programs to ensure that in-flight anomalies are resolved.	28) Develop a clear process for management chain of command and communications within a program and among government organizations and program management/contractor interfaces for anomaly request and resolution. a. Develop streamlined and rapid escalation process for	Leadership

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					communicating information of critical mission importance b. Develop communications process up/down escalation path, which also provides for horizontal and informal communications integration. c. Develop independent conflict resolution process for anomaly mediation and resolution that would stop "normalization of deviance". d. Develop a website and hotline for the reporting of program concerns for third parties. Appropriate escalation procedures need to be determined for timely notification. e. Provide training and assistance if needed. <u>Responsibility</u>: Code AE	
F60	F6.1-5	Foam bipod debris-shedding incidents on STS-52 and STS-62 were undetected at the time they occurred, and were not discovered until the Board directed NASA to examine External Tank separation images more closely.				
F61	F6.1-6	Foam bipod debris-shedding events were classified as In-Flight Anomalies up until STS-112, which was the first known bipod foam-shedding event not classified as an In-Flight Anomaly.	Y	An independent organization should identify all deviations from program requirements. Unless a requirement is determined as an over-specification and formally waived, any deviation from a design requirement should not be relegated to a lower status.	See F6.1-2	Organizational Structure
F62	F6.1-7	The STS-112 assignment for the External Tank Project to "identify the cause and corrective action of the bipod ramp foam loss event" was not due until after the planned launch of STS-113, and then slipped to after the launch of STS-107.				
F63	F6.1-8	No External Tank configuration changes				

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		were made after the bipod foam loss on STS-112.				
F64	F6.1-9	Although it is sometimes possible to obtain imagery of night launches because of light provided by the Solid Rocket Motor plume, no imagery was obtained for STS-113.				
F65	F6.1-10	NASA failed to adequately perform trend analysis on foam losses. This greatly hampered the agency's ability to make informed decisions about foam losses.	Y	All anomalies must be captured, well documented and researched to determine if they represent unique or systemic problems.	29) Develop a standard and process for anomaly identification, trending, classification, tracking, and resolution management. a. Develop a process for root cause analysis, resolution, and documentation. b. Perform at least 3 program audits to assure compliance with standards. c. Develop a standard for the periodic independent review of this process. Responsibility: Code AE	Risk Management
F66	F6.1-11	Despite the constant shedding of foam, the Shuttle Program did little to harden the Orbiter against foam impacts through upgrades to the Thermal Protection System. Without impact resistance and strength requirements that are calibrated to the energy of debris likely to impact the Orbiter, certification of new Thermal Protection System tile will not adequately address the threat posed by debris.				
F67	F6.2-1	NASA Headquarters' focus was on the Node 2 launch date, February 19, 2004.	Y	Executive management's decisions will benefit from a better understanding of program milestones and associated changing risks before casting schedules in stone. They should not force decisions to be schedule-driven without understanding the implications.	30) Expand upon the process for independent program reviews (Independent Assessments, Independent Implementation Reviews, and Non-Advocate Reviews) that require re-review when any interim major milestone slips to determine the impact on mission completion schedule and cost risk.	Leadership

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					Responsibility: Code AE	
F68	F6.2-2	The intertwined nature of the Space Shuttle and Space Station programs significantly increased the complexity of the schedule and made meeting the schedule far more challenging.	Y	NASA programs should be managed with an Agency-wide system and operational optimization perspective. This applies to both operational and infrastructure programs.	31) Perform a comprehensive assessment of major program interdependencies. a. Analyze the data from the Integrated Financial Management Program (IFMP) to cross check this analysis in terms of perception and reality. b. Develop an assessment of the full cost implications of individual program requirements changes on other programs to ensure that cost- effective decisions are the result. c. Identify cross-programmatic dependencies and cross-programmatic risk factors. d. Each program should identify its own interdependencies, which are recognized in the program plans and risk assessments. e. Reevaluate individual program requirements based on this analysis. Responsibility: Code AE	Organizational Structure
F69	F6.2-3	The capabilities of the system were being stretched to the limit to support the schedule. Projections into 2003 showed stress on vehicle processing at the Kennedy Space Center, on flight controller training at Johnson Space Center, and on Space Station crew rotation schedules. Effects of this stress included neglecting flight controller recertification requirements, extending crew rotation schedules, and adding incremental risk by scheduling additional Orbiter movements at Kennedy.	Y	NASA needs to audit its staffing practices and workforce management practices in terms of surge and certifications. Data needs to be provided to executive management regarding personnel burnout, loss of certifications, errors, etc., so that executives can make appropriate determinations.	32) Develop a clear process for management chain of command for program management. a. Identify clear requirements for advancement or reassignment to positions in terms of required training and skill, not simply meeting minimum qualification standards. b. Develop a standard for the application of overtime and surge duration based on demonstrated industry best practices for other Federal agencies and similar commercial enterprises.	Leadership

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					c. Develop a standard for requirements for certifications and a notification method for employee recertification and training. d. Review and modify NASA policies and practices concerning staffing, workforce management, and certifications. e. Conduct an audit of at least three programs for compliance. Responsibility: Code AE	
F70	F6.2-4	The four flights scheduled in the five months from October 2003, to February 2004, would have required a processing effort comparable to the effort immediately before the *Challenger* accident.				
F71	F6.2-5	There was no schedule margin to accommodate unforeseen problems. When flights come in rapid succession, there is no assurance that anomalies on one flight will be identified and appropriately addressed before the next flight.	Y	All programs including those associated with NASA infrastructure should allow adequate schedule margin to accommodate unforeseen problems.	33) Perform an assessment of best industry practices for R&D, completion, and operational programs to assess the management of schedule and cost risk through the development of management reserves. a. Perform an assessment of the planned versus actual time and cost transition across Technology Readiness Levels (TRL) to benchmark NASA performance against other federal agencies. b. Develop a standard associated with program development and planning that incorporates independent reviews. Responsibility: Code AE	Leadership
F72	F6.2-6	The environment of the countdown to Node 2 and the importance of maintaining the schedule may have begun	Y	Minority views and engineering intuition are important sources of information that employees should feel comfortable	See F6.1-4	Leadership

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		to influence managers' decisions, including those made about the STS-112 foam strike.		offering without fear of retribution.		
F73	F6.2-7	During STS-107, Shuttle Program Managers were concerned with the foam strike's possible effect on the launch schedule.				
F74	F6.3-1	The foam strike was first seen by the Intercenter Photo Working Group on the morning of Flight Day Two during the standard review of launch video and high-speed photography. The strike was larger than any seen in the past, and the group was concerned about possible damage to the Orbiter. No conclusive images of the strike existed. One camera that may have provided an additional view was out of focus because of an improperly maintained lens.				
F75	F6.3-2	The Chair of the Intercenter Photo Working Group asked management to begin the process of getting outside imagery to help in damage assessment. This request, the first of three, began its journey through the management hierarchy on Flight Day Two.	Y	Streamlined lines of communication and requests need to be identified for time-critical requirements that may have adverse effects on program success.	See F6.1-4	Leadership
F76	F6.3-3	The Intercenter Photo Working Group distributed its first report, including a digitized video clip and initial assessment of the strike, on Flight Day Two. This information was widely disseminated to NASA and contractor engineers, Shuttle Program managers, and Mission Operations Directorate personnel.				
F77	F6.3-4	Initial estimates of debris size, speed, and origin were remarkably accurate. Initial information available to managers stated that the debris originated in the left bipod area of the External Tank, was quite large, had a high velocity, and struck the underside of the left wing near its leading				

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		edge. The report stated that the debris could have hit the RCC or tile.				
F78	F6.3-5	A Debris Assessment Team began forming on Flight Day Two to analyze the impact. Once the debris strike was categorized as "out of family" by United Space Alliance, contractual obligations led to the Team being Co-Chaired by the cognizant contractor sub-system manager and her NASA counterpart. The team was not designated a Tiger Team by the Mission Evaluation Room or Mission Management Team.				
F79	F6.3-6	Though the Team was clearly reporting its plans (and final results) through the Mission Evaluation Room to the Mission Management Team, no Mission manager appeared to "own" the Team's actions. The Mission Management Team, through the Mission Evaluation Room, provided no direction for team activities, and Shuttle managers did not formally consult the Team's leaders about their progress or interim results.	Y	Best business practices define individual responsibility, accountability, and authority including well-defined chains of command and organized methods for dissent.	See F6.1-4	Leadership
F80	F6.3-7	During an organizational meeting, the Team discussed the uncertainty of the data and the value of on-orbit imagery to "bound" their analysis. In its first official meeting the next day, the Team gave its NASA Co-Chair the action to request imagery of *Columbia* on-orbit.				
F81	F6.3-8	The Team routed its request for imagery through Johnson Space Center's Engineering Directorate rather than through the Mission Evaluation Room to the Mission Management Team to the Flight Dynamics Officer, the channel used during a mission. This routing diluted the urgency of their request. Managers viewed it as a non-critical engineering desire rather than a critical operational need.	Y	Clear lines of reporting within and across organizations need to be identified, documented, rehearsed, and adhered to.	See F6.1-4	Leadership

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F82	F6.3-9	Team members never realized that management's decision against seeking imagery was not intended as a direct or final response to their request.	Y	Feedback systems involved in channels of decision-making need to be developed and adhered to, so that the workforce is aware of the status and rationale of decisions throughout the process.	See F6.1-4	Leadership
F83	F6.3-10	The Team's assessment of possible tile damage was performed using an impact simulation that was well outside CRATER's test database. The Boeing analyst was inexperienced in the use of CRATER and the interpretation of its results. Engineers with extensive Thermal Protection System expertise at Huntington Beach were not actively involved in determining if the CRATER results were properly interpreted.	Y	Same as R3.8-2	See R3.8-2	Technical Capabilities
F84	F6.3-11	Crater initially predicted tile damage deeper than the actual tile depth, but engineers used their judgment to conclude that damage would not penetrate the densified layer of tile. Similarly, RCC damage conclusions were based primarily on judgment and experience rather than analysis.	Y	Personnel need to be adequately trained in model use, limitations, and escalation procedures when issues arise. Engineers, when faced with results that defy "reality checks," should double check the model then raise their concerns.	See R3.8-2	Technical Capabilities
F85	F6.3-12	For a variety of reasons, including management failures, communication breakdowns, inadequate imagery, inappropriate use of assessment tools, and flawed engineering judgments, the damage assessments contained substantial uncertainties.	Y	Many programs across NASA have similar scopes across multiple organizations and likely have similar potential problems.	See F6.1-4	Leadership
F86	F6.3-13	The assumptions (and their uncertainties) used in the analysis were never presented or discussed in full to either the Mission Evaluation Room or the Mission Management Team.				
F87	F6.3-14	While engineers and managers knew the foam could have struck RCC panels; the briefings on the analysis to the Mission Evaluation Room and Mission Management Team did not address RCC damage, and neither Mission Evaluation				

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		Room nor Mission Management Team managers asked about it.				
F88	F6.3-15	There were lapses in leadership and communication that made it difficult for engineers to raise concerns or understand decisions. Management failed to actively engage in the analysis of potential damage caused by the foam strike.	Y	Subject matter experts need to be heard and understood when problems arise that could affect mission success. Communications through viewgraphs does not work and decisions need to be documented and communicated to all parties.	See F6.1-4	Leadership
F89	F6.3-16	Mission Management Team meetings occurred infrequently (five times during a 16 day mission), not every day, as specified in Shuttle Program management rules.	Y	Operations procedures and checklist need to be verified, communicated, and followed for all programs.	See F6.1-1	Processes & Rules
F90	F6.3-17	Shuttle Program Managers entered the mission with the belief, recently reinforced by the STS-113 Flight Readiness Review, that a foam strike is not a safety-of-flight issue.				
F91	F6.3-18	After Program managers learned about the foam strike, their belief that it would not be a problem was confirmed (early, and without analysis) by a trusted expert who was readily accessible and spoke from "experience." No one in management questioned this conclusion.	Y	Experience should not be used to dismiss concerns about safety and mission success without a logical rationale to support the conclusion. NASA needs to instill a practice in which management should prove that a problem is not a problem rather than reversing the burden of proof.	See F6.1-4	Leadership
F92	F6.3-19	Managers asked *"Who's requesting the photos?"* instead of assessing the merits of the request. Management seemed more concerned about the staff following proper channels (even while they were themselves taking informal advice) than they were about the analysis.	Y	There are many programs in NASA that have large organizations with potential problems. Leaders need to develop processes to address the merits of problems rather than the individuals raising the problems.	See F6.1-4	Leadership
F93	F6.3-20	No one in the operational chain of command for STS-107 held a security clearance that would enable them to understand the capabilities and limitations of National imagery resources.	Y	Many programs would benefit from Program Managers holding active clearances. NASA should review clearances agency-wide to determine which are appropriate and should be active to achieve safety and mission success.	34) Determine if NASA needs a central source for maintaining security clearances. a. Develop a list of cleared personnel at all clearance levels, and maintain the list at the appropriate security level. Correlate the organizational	Processes & Rules

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					chain of command for each major program with the clearance list. b. Review the security requirements for each major program, and determine if the number of cleared personnel is sufficient to effectively run the program during normal and crisis/emergency operations. c. Submit requests for additional cleared personnel to meet the delta between current and required. Responsibility: Code X	
F94	F6.3-21	Managers associated with STS-107 began investigating the implications of the foam strike on the launch schedule, and took steps to expedite post-flight analysis.				
F95	F6.3-22	Program managers required engineers to prove that the debris strike created a safety-of-flight issue: that is, engineers had to produce evidence that the system was unsafe rather than prove that it was safe.	Y	There are many programs in NASA that have large hierarchical organizations. However, problems are identified throughout the organizations at every level. Leaders need to develop processes to address the merits of problems regardless of the source within the hierarchy.	See F6.1-4	Leadership
F96	F6.3-23	In both the Mission Evaluation Room and Mission Management Team meetings over the Debris Assessment Team's results, the focus was on the bottom line – was there a safety-of-flight issue, or not? There was little discussion of analysis, assumptions, issues, or ramifications.	Y	Managers need to base critical mission decisions on facts, not intuition. Many programs may be faced with similar situations, in particular where analysis teams are located at dispersed locations. Processes need to be in place to accommodate such circumstances.	See R6.3-1	Learning
F97	F6.3-24	Communication did not flow effectively up to or down from Program managers.	Y	Some NASA programs span multiple Centers and geographic locations, so this problem could be more widespread than the Space Shuttle Program. Communication paths should be clearly documented.	35) Review communications policies and reports. The review will focus on the requirements for formal reporting during normal and emergency/crisis times. For formal reporting during normal operating tempo, the frequency of the reports shall be	Communication

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					determined, and who produces/reviews, and approves these reports. a. After review of policies, conduct an audit of no less than three programs to determine compliance and methods used. If the programs are compliant, determine if the methods used are adequate. b. Rewrite the policy(s) if required. c. Provide training and assistance. Responsibility: Code AE	
F98	F6.3-25	Three independent requests for imagery were initiated.				
F99	F6.3-26	Much of Program Managers' information came through informal channels, which prevented relevant opinion and analysis from reaching decision makers.	Y	Formal reporting paths and chain of command need to be codified, implemented, and rehearsed in all programs, and need to accommodate informal sources of information.	See F6.3-24	Communication
F100	F6.3-27	Program Managers did not actively communicate with the Debris Assessment Team. Partly as a result of this, the Team went through institutional, not mission-related, channels with its request for imagery, and confusion surrounded the origin of imagery requests and their subsequent denial.	Y	Formal reporting paths and chain of command need to be codified, implemented, and rehearsed in all programs, including feedback mechanisms.	See F6.3-24	Communication
F101	F6.3-28	Communication was stifled by the Shuttle Program attempts to find out who had a "mandatory requirement" for imagery.				
F102	F6.3-29	Safety representatives from the appropriate organizations attended meetings of the Debris Assessment Team, Mission Evaluation Room, and Mission Management Team, but were passive, and therefore were not a channel through which to voice concerns or dissenting views.	Y	Rules of engagement and organizational responsibilities should be clearly identified across all programs. Employees should be trained and encouraged to raise issues proactively when their concerns, insights, or knowledge would impact safety and mission success.	See F6.3-24	Communication
F103	F6.4-1	The repair option, while logistically viable using existing materials onboard				

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		Columbia, relied on so many uncertainties that NASA rated this option "high risk."				
F104	F6.4-2	If Program managers were able to unequivocally determine before Flight Day Seven that there was potentially catastrophic damage to the left wing, accelerated processing of *Atlantis* might have provided a window in which *Atlantis* could rendezvous with *Columbia* before *Columbia*'s limited consumables ran out.				
F105	F7.1-1	Throughout its history, NASA has consistently struggled to achieve viable safety programs and adjust them to the constraints and vagaries of changing budgets. Yet, according to multiple high level independent reviews, NASA's safety system has fallen short of the mark.	Y	NASA needs to audit its staffing practices and workforce management practices in terms of surge and certifications. Data needs to be provided to executive management regarding personnel burnout, loss of certifications, errors, etc., so that executives can make appropriate determinations.	See R7.5-2	Organizational Structure
F106	F7.4-1	The Associate Administrator for Safety and Mission Assurance is not responsible for safety and mission assurance execution, as intended by the Rogers Commission, but is responsible for Safety and Mission Assurance policy, advice, coordination, and budgets. This view is consistent with NASA's recent philosophy of management at a strategic level at NASA Headquarters but contrary to the Rogers' Commission recommendation.				
F107	F7.4-2	Safety and Mission Assurance organizations supporting the Shuttle Program are largely dependent upon the Program for funding, which hampers their status as independent advisors.	Y	Programs need to perform assessments to identify potential conflicts of interest that can compromise independence.	See R7.5-2	Organizational Structure
F108	F7.4-3	Over the last two decades, little to no progress has been made toward attaining integrated, independent, and detailed analyses of risk to the Space Shuttle	Y	NASA needs to develop a uniform standard of risk assessment and management and apply it to all of its programs including missions and	36) Review current policies and standards for Risk Assessment to include cost, technical, and schedule risk considerations.	Risk Management

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		system.		infrastructure programs.	a. After review of policies, conduct an audit of no less than three programs to determine compliance and methods used. If the programs are compliant, determine if the methods used are adequate. b. Rewrite the policy(s) if required. c. Develop a standard for Risk Analysis. d. Provide training and assistance. <u>Responsibility</u>: Code Q	
F109	F7.4-4	System safety engineering and management is separated from mainstream engineering, is not vigorous enough to have an impact on system design, and is hidden in the other safety disciplines at NASA Headquarters.	Y	An Agency-wide safety and engineering organization that integrates system safety engineering and management with mainstream engineering should be evaluated.	See R7.5-1	Organizational Structure
F110	F7.4-5	Risk information and data from hazard analyses are not communicated effectively to the risk assessment and mission assurance processes. The Board could not find adequate application of a process, database, or metric analysis tool that took an integrated, systemic view of the entire Space Shuttle system.	Y	NASA needs to develop a uniform standard of risk assessment and management and apply it to all of its programs including missions and infrastructure programs.	See F7.4-3	Risk Management
F111	F7.4-6	The Space Shuttle Systems Integration Office handles all Shuttle systems except the Orbiter. Therefore, it is not a true integration office.	Y	Programs need to have clear organizational responsibilities whether they are geographically dispersed or managed across centers. Programs need to assess their organizations to determine interdependencies and collaborative opportunities that would impact safety and mission success.	37) Review current policies and standards from an organizational structure and responsibility perspective. a. Conduct a comprehensive review of organizational structures across NASA with an emphasis on the organization's ability to do systems integration. b. Rewrite the policy(s) if required. c. Create an organization standard and mandate for program and integration offices. d. Provide training and assistance. <u>Responsibility</u>: Code AE	Organizational Structure

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F112	F7.4-7	When the Integration Office convenes the Integration Control Board, the Orbiter Office usually does not send a representative, and its staff makes verbal inputs only when requested.				
F113	F7.4-8	The Integration office did not have continuous responsibility to integrate responses to bipod foam shedding from various offices. Sometimes the Orbiter Office had responsibility, sometimes the External Tank Office at Marshall Space Flight Center had responsibility, and sometimes the bipod shedding did not result in any designation of an In-Flight Anomaly. Integration did not occur.	Y	Programs must determine clear organizational lines of authority, responsibility, and accountability.	See F7.4-6	Organizational Structure
F114	F7.4-9	NASA information databases such as The Problem Reporting and Corrective Action and the Web Program Compliance Assurance and Status System are marginally effective decision tools.	Y	NASA should assess decision support tool effectiveness for program management, problem identification, and problem resolution.	38) Review current policies and standards for decision support tools. a. Conduct a comprehensive review of all NASA decision support tools, and compile a directory. b. Rewrite the policy(s) if required. c. Create a common standard and mandate for decision support systems across NASA. d. Provide training and development assistance on decision support tools. See F7.4-10/11 Responsibility: Code AE	Learning
F115	F7.4-10	Senior Safety, Reliability & Quality Assurance and element managers do not use the Lessons Learned Information System when making decisions. NASA subsequently does not have a constructive program to use past lessons to educate engineers, managers, astronauts, or safety personnel.	Y	Training programs that leverage case studies and lessons learned capabilities are characteristic of other Federal and commercial organizations and should be adopted by NASA and implemented across the entire Agency as appropriate.	See F7.4-11	Learning
F116	F7.4-11	The Space Shuttle Program has a wealth of data tucked away in multiple databases	Y	NASA should address database commonality and real-time access just as	39) Review current policies and standards for databases and	Learning

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		without a convenient way to integrate and use the data for management, engineering, or safety decisions.		it did for the Integrated Financial Management Program (IFMP).	knowledge sharing. a. Conduct a comprehensive review of all NASA databases, and compile a directory. b. Rewrite the policy(s) if required. c. Create a common standard and mandate for database real-time access across NASA. d. Provide training and development assistance on the database standard and associated real-time access process that is developed. <u>Responsibility</u>: Code AE	
F117	F7.4-12	The dependence of Safety, Reliability & Quality Assurance personnel on Shuttle Program support limits their ability to oversee operations and communicate potential problems throughout the organization.	Y	Programs should identify internal conflicts of interest and address means for mitigation.	See R7.5-2	Organizational Structure
F118	F7.4-13	There are conflicting roles, responsibilities, and guidance in the Space Shuttle safety programs. The Safety & Mission Assurance Pre-Launch Assessment Review process is not recognized by the Space Shuttle Program as a requirement that must be followed (NSTS 22778). Failure to consistently apply the Pre-Launch Assessment Review as a requirements document creates confusion about roles and responsibilities in the NASA safety organization.	Y	Programs should perform periodic audits to identify internal conflicts of interest; process conflicts; and other program operational inconsistencies, roles, and responsibilities and address means for mitigation.	See R7.5-2	Organizational Structure
F119	F10.1-1	The *Columbia* accident demonstrated that Orbiter breakup during re-entry has the potential to cause casualties among the general public.	Y	Same as O10.1-1	See O10.1-1	Risk Management
F120	F10.1-2	Given the best information available to date, a formal risk analysis sponsored by the Board found that the lack of general-public casualties from *Columbia*'s break-up was the expected outcome.	Y	Programs should know all results of risk analyses, regardless of the anticipated outcome, and factor those considerations into safety and mission success planning and contingency management activities.	See O10.1-1	Risk Management

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F121	F10.1-3	The history of U.S. space flight has a flawless public safety record. Since the 1950s, hundreds of space flights have occurred without a single public injury.	Y	Safety should be based on logical risk assessments. Small sample statistics provide for an uninformed development of intuition.	See O10.1-1	Risk Management
F122	F10.1-4	The FAA and U.S. space launch ranges have safety standards designed to ensure that the general public is exposed to less than a one-in-a-million chance of serious injury from the operation of space launch vehicles and unmanned aircraft.	Y	NASA policies recognize requirements for public safety. Those policies should be reviewed and the models used should be continually updated and assessed with respect to value in supporting timely decision making.	See O10.1-1	Risk Management
F123	F10.1-5	NASA did not demonstrably follow public risk acceptability standards during past Orbiter re-entries. NASA efforts are underway to define a national policy for the protection of public safety during all operations involving space launch vehicles.	Y	Same as F10.1-4	See O10.1-1	Risk Management
F124	F10.3-1	The engineering drawing system contains outdated information and is paper-based rather than computer-aided.	Y	Accurate and comprehensive engineering drawings should be maintained for all programs. These drawings must be computer-aided.	See R10.3-1	Technical Capabilities
F125	F10.3-2	The current drawing system cannot quickly portray Shuttle sub-systems for on-orbit troubleshooting.				
F126	F10.3-3	NASA normally uses closeout photographs but lacks a clear system to define which critical sub-systems should have such photographs. The current system does not allow the immediate retrieval of closeout photos.	Y	Standards for taking, organizing, preserving, handling, and managing closeout photographs should be uniformly applied across all of NASA's programs.	See R10.3-1	Technical Capabilities
F127	F10.4-1	Shuttle System industrial safety programs are in good health.	Y	The state of health of all NASA industrial safety programs should be reviewed.	40) Review current policies and regulations on industrial safety programs. a. After review of policies and regulations, conduct an audit of no less than three programs to determine compliance. b. Compile the results; develop a recommendation. c. If required, rewrite the policies to comply with regulations.	Risk Management

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA[*]	Diaz Summary Discussion	Specific Action	Category
					Responsibility: Code Q	
F128	F10.4-2	The Quality Planning Requirements Document, which defines inspection conditions, was well formulated. However, there is no requirement that it be routinely reviewed.				
F129	F10.4-3	Kennedy Space Center's current government mandatory inspection process is both inadequate and difficult to expand, which inhibits the ability of Quality Assurance to process improvement initiatives.				
F130	F10.4-4	Kennedy's quality assurance system encourages inspectors to allow incorrect work to be corrected without being labeled "rejected." These opportunities hide "rejections," making it impossible to determine how often and on what items frequent rejections and errors occur.				
F131	F10.8-1	The present design and fabrication of the lower carrier panel attachments are inadequate. The bolts can readily pull through the relatively large holes in the box beams.				
F132	F10.8-2	The current design of the box beam in the lower carrier panel assembly exposes the attachment bolts to a rapid exchange of air along the wing, which enables the failure of numerous bolts.				
F133	F10.8-3	Primers and sealants such as Room Temperature Vulcanizing 560 and Koropon may accelerate corrosion, particularly in tight crevices.				
F134	F10.8-4	The negligible compressive stresses that normally occur in A-286 bolts help protect against failure.				
F135	F10.9-1	The Hold-Down Post External Tank Vent Arm System is a Criticality 1R (redundant) system. Before the anomaly on STS-112, and despite the high-criticality factor, the original cabling for this system was used repeatedly until it				

* Broadly Applicable

Diaz Team #	CAIB #	CAIB Report Recommendations and Pertinent Factors	BA*	Diaz Summary Discussion	Specific Action	Category
		was visibly damaged. Replacing these cables after every flight and removing the Kapton will prevent bending and manipulation damage.				
F136	F10.9-2	NASA is unclear about the potential for damage if the system malfunctions, or even if one nut fails to split. Several program managers were asked: What if the A system fails, and a B-system initiator fails simultaneously? The consensus was that the system would continue to burn on the pad or that the Solid Rocket Booster would rip free of the pad, causing potentially catastrophic damage to the Solid Rocket Booster skirt and nozzle maneuvering mechanism. However, they agree that the probability of this is extremely low.				
F137	F10.9-3	With the exception of STS-112's anomaly, numerous bolt hang-ups, and occasional Master Events Controller failures, these systems have a good record. In the early design stages, risk-mitigating options were considered, including strapping with either a wire that crosses over the nut from the A to B side, or with a toggle circuit that sends a signal to the opposite side when either initiator fires. Both options would eliminate the potential of a catastrophic dual failure. However, they could also create new failure potentials that may not reduce overall system risk. Today's test and troubleshooting technology may have improved the ability to test circuits and potentially prevent intermittent failures, but it is not clear if NASA has explored these options.				

* Broadly Applicable

Appendix B Acronyms

ADA	Associate Deputy Administrator
ADA/I	Associate Deputy Administrator – Institutions and Asset Managment
ADA/T	Associate Deputy Administrator – Technical Programs
APPL	Academy for Program and Project Management
ASME	American Society of Mechanical Engineers
BMAR	Backlog of Maintenance and Repair
CAIB	Columbia Accident Investigation Board
CATS	Corrective Action Tracking System
CAWAM	CAIB Agency-wide Action Matrix
CIO	Chief Information Officer
CNSI	Classified National Security Information
CRM	Continuous Risk Management
CTF	Continuing Task Force
CVS	Clearance Verification System
DCAA	Defense Contract Audit Agency
DFRC	Dryden Flight Research Center
DOD	Department of Defense
DOE	Department of Energy
EC	Enterprise Committee
EMB	Engineering Management Board
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulations
GAO	General Accounting Office
GSFC	Goddard Space Flight Center
IAM	Integrated Asset Management
IPAO	Independent Program Analysis Organization
IPO	Institutional Program Office
ITEA	Independent Technical Engineering Authority
ISO	International Standards Organization
ISS	International Space Station
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KM	Knowledge Management
LaRC	Langley Research Center
MDI	Mission Dependency Index
MMOD	Micrometeoroid and Orbital Debris
MOA	Memorandum of Agreement
NAIT	NASA Accident Investigation Team
NAPA	National Academy of Public Administration
NAR	Non Advocate Review
NASA	National Aeronautics and Space Administration
NEED	NASA Engineering Expertise Directories
NESC	NASA Engineering and Safety Center
NET	NASA Engineering Training
NGA	National Geospatial-Intelligence Agency
NODIS	NASA Online Directives Information System
NPD	NASA Policy Directive
NPG	NASA Policy Guidance
NPR	NASA Procedural Requirements
NRC	National Research Council
OCE	Office of the Chief Engineer
OIG	Office of the Inspector General
OSHA	Occupational Safety and Health Association
OSMA	Office of Safety and Mission Assurance
PEP	Performance Evaluation Profile

PMC	Program Management Council
PMCWG	Program Management Council Working Group
R-O-Fs	Requirements, Observations, and Findings
RPMG	Real Property Mission Analysis
R&D	Research and Development
R&T	Research and Technology
SOLAR	Site for On-line Learning and Resources
SCI	Sensitive Compartmented Information
S&MA	Safety and Mission Assurance
SEI CMM	Software Engineering Institute Capabilities Maturity Model
SMO	Systems Management Office
TBD	To Be Determined
TDP	Testing Designated Position
VPP	Voluntary Protection Program

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